JUN 21 1928

ARMY ORDNANCE

VOL. VIII MAY-JUNE, 1928 No. 48

ANTIAIRCRAFT GUNS IN ACTION

OUR PROBLEM OF MUNITIONMENT
Col. Frank A. Scott, Ord. Res., U. S. A.

PROGRESS IN THE STANDARDIZATION OF ORDNANCE
Col. W. H. Tschappat, Ord. Dept., U. S. A.

AUTOMOTIVE EQUIPMENT OF THE ARMY
Maj. Levin H. Campbell, Ord. Dept., U. S. A.

CURVED VS. CARTESIAN COORDINATES IN BALLISTICS
Maj. Roger Sherman Hoar, Ord. Res., U. S. A.

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The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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Published by
THE ARMY ORDNANCE ASSOCIATION
806 Mills Building, Washington, D. C.

Issued Bi-Monthly. Single Copy 75c.
Subscription rate: Continental U. S. $4.50 per annum, foreign $5.00, in advance. Entered as second-class matter August 14, 1920, at the Post Office at Washington, D. C., under the Act of March 3, 1879. Additional entry at Richmond, Va.

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THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guarantee of peace.

THE Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

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The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace;

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To promote mutual understanding and to effect cooperation with American Scientists, Inventors, Engineers and Manufacturers in civil life and the Regular and Reserve Officers of the Army Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the Industry of the Nation and by the Officers and Civilian Employees of the Ordnance Department in the wars in which the United States has been engaged.

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Fort McHenry, Md., Birthplace of The Star-Spangled Banner

Unsightly for many years, Fort McHenry, Md., the birthplace of our National Anthem, is at last to be restored. Funds recently have been provided by the Congress to enable the War Department to proceed with the restoration of the historic site to its original condition. The authorization of the permanent preservation of this national park and perpetual national memorial shrine as the birthplace of the Star-Spangled Banner, written by Francis Scott Key, will serve ultimately to provide a splendid national monument commemorating the defense of the fort against the bombardment by the British fleet in 1814 and the birth of our National Anthem.

The Star-Spangled Banner still flies at the same spot on which Francis Scott Key viewed it from the British vessel whereon he was detained. The original staff from which the national colors flew on that memorable morning has fallen long since, but successive flag poles have been planted on the exact spot occupied by the original.

ARMY ORDNANCE

VOL. VIII MAY-JUNE, 1928 No. 48

Our Problem of Munitionment

By Col. Frank A. Scott,* Ord. Res. U. S. A.

WE TAKE our text from First Samuel, 17th Chapter —a long text as befits a long sermon:

"And there went out a champion, out of the camp of the Philistines, named Goliath; and his height was six cubits and a span; and he had an helmet of brass upon his head; and he was armed with a coat of mail weighing 5,000 shekels of brass and he had greaves of brass upon his legs and a target of brass between his shoulders, and the staff of his spear was like a weaver's beam, and his spear's head weighed 600 shekels of iron" (you see he had a load almost heavy enough to satisfy even the infantry higher-ups of his day) "and one bearing a shield went before him."

And David "took his staff in his hand and chose him five smooth stones out of the brook . . . . and his sling was in his hand and he drew near to the Philistine . . . . and David put his hand in his bag and took thence a stone and slang it and smote the Philistine in his forehead, that the stone sunk into his forehead and he fell upon his face to the earth."

The superior, well directed fire of the Jew overwhelmed the Philistine. "Sic transit gloria mundi!" Goliath, disappearing from the roll of those present for duty, appears then and ever since on the pages of history—profane and sacred—a victim, an early and eloquent victim, of superior armament; and thereby establishes a custom faithfully observed ever since, of finding explanation for defeat in the superior munitionment of the adversary; supplying us, also, our first example of the failure of the higher-ups to foresee the power and effect of new weapons.

Nor may we overlook Saul, for the evidence shows that being David's higher-up, he considerately essayed to furnish David with the accepted equipment dictated by his own experience and traditions. David, always an effective speaker, pleaded lack of transport, and so escaped responsibility for government property not needed to attain his objective.

OBSERVE how true to form we still run. While young, like David, and regarded as fit only to carry cheeses to camp, we dream of conquest, use our imaginations, trust our own views, and desire only to be allowed to have our fling. Anon, we find ourselves a higher-up and among the Sauls of our day. Faithful then to our experience and traditions, we prefer rather to die with our armor on than risk ourselves, bare-legged, with nothing but a sling.

Great ability and high character are sometimes joined with inability to appraise the significance of progress. Admiral Farragut is said to have opposed the adoption of iron-clads. Earl Balfour and Lord Northcliffe each related to me, in 1917, the story of Earl Kitchener's disbelief in great numbers of large caliber guns and high explosive shells.

The failure of the higher-ups to exercise prevision is a favorite theme in all military services. If this were the whole story, the solution of the problem would be easy. Again laying our course by the scriptures, we would have only to "put down the mighty from their seat and exalt the humble and meek."

Unfortunately for us who have to study it, the art of war is not so elemental as this. It changes many of its forms with the advance of the civilized arts, and the ascending spiral of progress keeps bringing back to us problems which at one time or another we regarded as satisfactorily solved.

We observe the tendency to recur to principles or methods long since rejected and then recalled by the demands of a new situation, or made available by collateral inventions. Repeating arms, invented in the 16th and 17th centuries and rejected or neglected, are made available in the 19th by the development of the metal cartridge; so, also, we see the pike rejected in favor of firearms; and then, because of the temporary disarming of the soldier when his piece is empty, the bayonet developed. We witness the rejection of the hand grenade and its recall and promotion to a place of added dignity; the Chinese stinkpot graduates from the realm of ridicule into the terrible menace of chemical warfare. Individual armor is rejected and then reassumed. Weight yields to the demand for mobility, and resulting weakness calls for the restoration of weight. The one-man tank is in no wise different in principle from the armored knight on an armored horse. The chief change in these two military elements, though they are separated by a period of five centuries, represents the difference in mechanical efficiency of the two periods.

The principle of a repeating small arm was developed to at least a workable, if not a satisfactory, stage centuries before its military value was recognized, and it was adopted by competent military authority. "Pepys Diary," July, 1662, contains the following: "Dined with the officers of the Ordnance, where Sir W. Compton, Mr. O'Neile and other great persons were. After dinner, was brought to Sir W. Compton a gun to discharge seven times; the best of all devices that I ever saw and not a dauble: for it is much approved of and many thereof made." We must remember that Pepys was Secretary of of the Royal Navy under Charles II and therefore, while not an Ordnance authority, was nevertheless a man of great experience.

It is unnecessary to pursue this phase of our subject to establish the existence of such arms at this early period, as specimens are still to be seen in London Tower, the Wallace Collection, London, and elsewhere. Faults aris-

*Chief, Cleveland Ordnance District; Director, Army Ordnance Association; Chairman, General Munitions Board and War Industries Board, 1917.

ing from the lack of fixed ammunition, with consequent premature explosion of reserve charges, etc., led to the almost complete disregard of these early repeaters. The military possibilities were evidently never regarded with sufficient seriousness to justify exhaustive study of the principle.

A further and comparatively recent example of this same failure to recognize and apply a valuable principle when already within the grasp of the authorities, is the breech-loading flintlock rifle, patented by Col. John H. Hall, in 1811, and manufactured at Harpers Ferry. Gas leaks between the breech block and barrel resulted in the condemnation of this valuable idea, although the piece itself was made and issued to our Army in various forms, from about 1816 until the Civil War. This was the first breech-loader adopted by any army, and yet the fact is, the vital possibilities of the breech-loading principle were either not recognized or were argued down by men devoted to tradition or paralyzed by the need of meeting other new problems if they adopted a breech-loading arm. According to Pollard,* one of the first patents granted by the British Patent Office for a breech-loading small arm was to Abraham Hill, in 1664, for "a new way of making a gun or pistoll, the breech whereof rises upon a hinge by a contrivance of a motion from under it, by which it is alsoe let down againe and bolted fastly by one and the same motion." This describes very well the process adopted by the American, Colonel Hall, in his rifle.

IF WAR were a science, it would be the most complex of all the sciences. If it is an art, it is the most all-embracing of the arts. In its beginnings it called for little beyond the skill, strength and courage of the individual fighting man. It has progressed until the differentiation of function and equipment involves, on the field, the co-operation of scores of occupations and, in the rear, the support of entire nations. Therefore if we depart at all from the traditional, in this involved and confusing agglomeration, we must endeavor to discriminate between the essential and the non-essential; between the most effective of our possibilities and the less effective; and then contrast our selections with the probable selections of all possible enemies. If, in any natural national aptitude or unique national resources possessed by us, we can discern elements of unusual strength, then obviously common sense would dictate emphasis upon such characteristics or resources. All David did was to utilize his natural aptitude for the sling.

History bristles with examples of failure to do either of these two things and, unfortunately, our own history is not free from them. Too often entire reliance has been placed on a single element of strength, ignoring the interdependence of the components of fighting forces; so at Crecy, Poitiers, and Agincourt we see the splendid mounted chivalry of France destroyed by a combination of mounted knights and unmounted archers; at Culloden, the Scottish Highlanders swept away by artillery and musketry before they can charge home with the claymore. In a more recent day, the French dependence on the chassepot, unquestionably superior to the German needle gun, fails to offset the weakness of the French artillery arm and faulty organization and invites the tragedy of Sedan. Gunpower, with even a very modest admixture of brains, is apt to prove irresistible. Bereft of this element, its detonation still creates noise, but little else.

IN THE World War, few things were more impressive than the reluctance of trained soldiers to admit the advantage of exploiting to the limit all mechanical opportunities. Why was such a ridiculously limited number of machine guns allotted per regiment in 1914, in the English, French and American armies, even after it was well known that the Germans had already allotted at least eighteen times as many? Why not reverse the mental process and conclude that if two machine guns per regiment were desirable, two hundred would be more desirable? It is no answer to say that it was a question of ammunition or transport or trained personnel. We all know the same objections have been made and overcome in the military experience of our country many times. Ammunition supply and transport was the stumbling block to the adoption of a breech-loading rifle in our Army prior to the Civil War. Yet we finally adopted the breech-loader and even the repeater; and in the midst of the most trying war of our history awarded contracts for a total of 315,945 breech-loaders of eighteen different makes. Far less than this number of any one of these in service during the second year of the war might easily have shortened the conflict by a year.

There are two points to be noted here: the tardiness with which the breech-loading principle was accepted; and the menace to military efficiency involved in the adoption of so many types with differing caliber and ammunition—some used paper cartridges and some metallic cartridges.

According to Pollard, the Federal Government, by 1865, had received and issued the following quantities of breech-loaders:

1,002	Ball	14,495	Merill
1,059	Ballard	1,000	Palmer
55,567	Burnside	20,000	Remington
22,782	Gallagher	30,062	Smith
1,052	Gibbs	94,156	Spencer
3,520	Hall	25,603	Starr
11,261	Joslyn	9,342	Union
892	Lindner	4,001	Warner
20,000	Maynard	151	Wesson

My own impression is that there were other breech-loaders bought and issued, so this list might be extended; but, taken as it stands, for the Ordnance Officer it certainly adds one more to the already known horrors of war!

As to breech-loaders in the early days, and especially as to repeaters, the real difficulty was the container for the charge; and until the metallic cartridge was developed, there was little prospect of using the repeating mechanism because the charges broke down or exploded prematurely in the magazines. However, earlier emphasis of the principle would have resulted in the earlier development of methods.

Now, also, contrast the objections raised to the adoption of a breech-loader prior to the war and the difficulties which it was claimed such adoption would involve, with the actual difficulties encountered by reason of the delay. And yet the principle was so valuable the arm had to be adopted notwithstanding the disadvantages involved. Most

*"A History of Firearms," Pollard.

of the difficulties cited in the early reports were imaginary or exaggerated, while the difficulties created by the delay were real indeed; and all the time the lessened fire power of the infantry was dragging on the war and adding to the casualties.

IF ANY doubt that breech-loaders might have shortened the Civil War, let them study the effect of the musketry fire at Antietam and Spotsylvania, where, in certain sections of the field, the opposing infantry lines held their places firing point-blank volleys into each other. The Confederate General John B. Gordon gives this testimony: "Spotsylvania furnished an unexampled muzzle to muzzle fire; the longest roll of incessant, unbroken musketry; the most splendid exhibition of individual heroism and personal daring for large numbers, who, standing in the freshly spilt blood of their fellows, faced for so long a period and at so short a range the flaming rifles." So evenly was the fire balanced that one company per regiment, armed with breech-loaders, would have furnished the preponderance of fire necessary for a decision. If further argument is needed, then study, also, the effect of the fire of Casement's Federal brigade at Franklin, one company of one regiment (65th Indiana) of which was armed with repeating rifles. In front of the Federal entrenchments at Franklin, the percentage of loss in the Confederate infantry is doubtless the highest loss suffered by any large body of infantry in modern battles until the Franco-Prussian War.

Maj. Gen. J. D. Cox, of the Federal Army, writing in 1897, has this to say of the fierce action at Franklin, Tenn., in November, 1864: "The improvements in repeating arms made since our Civil War, and the current discussion of the practical range and rapidity of fire from a line of battle, receive light from our experience at Franklin. We found that the slight undulations of the field were scarcely noticeable from our parapet, and yet they were sufficient to cover Hood's advancing lines of infantry so well that they got within five or six hundred yards of our lines practically unharmed from musketry. We rarely found a field, during the war, so open or so level as this, and one might fairly be sceptical as to the practical value of much greater range in small arms.

"As to rapidity of fire, however, the proof seems strongly in its favor. The few repeating rifles we had bore no important ratio to the number of men in line, though the enemy, exaggerating the number of such weapons, credited them with much of the terrible destruction of the field."

Note, particularly, General Cox's expression, "the enemy, exaggerating the number of such weapons (repeating rifles), credited them with much of the terrible destruction of the field." Superior munitionment, wherever it is known, not only creates a moral as well as a physical advantage during the action, but it is liable to be the explanation used by any beaten force. Any new element, therefore, is apt to receive credit for a degree of superiority not actually possessed. Thus, the iron ramrods of the Prussians, during the great Frederick's time, against the wooden ones of the Austrians, and even the tanks at Cambrai, may develop a fictitious value which justifies the student in a careful review before accepting the popular conclusion.

Some people reason on this subject as though only those parts of the picture at which they are looking will change when the kaliedoscope turns over; whereas, of course, the whole picture changes.

The Confederate armies were not as well munitioned as the Northern armies, after the early months of the war. The reason was paucity of industrial plants and population, and Federal control of the sea. The Confederate Chief of Ordnance, General Gorgas, performed a stupendous task with impressive efficiency, but even he was unable fully to overcome the underlying disadvantages.

In his description of First Bull Run, General Longstreet refers several times to the disastrous effect on the Confederates of the power, efficiency, and good handling of the Federal artillery; and he attributes McDowell's loss of the battle to the capture of his two regular batteries, Griffin's and Rickett's, in these words: "Before the loss of his artillery, McDowell was the Samson of the field; now he was not only shorn of his power, but some of his mighty strength was transferred to his adversary."

Gen. E. P. Alexander, Longstreet's Chief of Artillery, and one of the most dependable of Confederate authorities, states that in 1862, at the time of the Antietam campaign, "the rifled ammunition of the Confederates was decidedly inferior to that of the enemy, many Confederate shells failing to burst, or bursting prematurely, or tumbling; and even the smooth-bore shells often burst near the guns."

Again, in a summary of the conditions of the Confederate Army, in the winter of 1864-1865, General Alexander asserts: "In addition to the scarcity of provisions, there was also threatened a deficiency of percussion caps. The supply for the campaign of 1864 had been maintained only by cutting up the copper stills of the country, but they were now exhausted and there was no more copper in sight."

Generals Longstreet, Alexander, and Pickett, who were the officers directly involved in Pickett's attack at Gettysburg, all testify to the shortage of ammunition in the artillery which made the preparatory bombardment for Pickett's charge, and attribute the brevity of fire and insufficient preparation to this shortage. There is nothing to show, however, that this was due to any cause other than the distance of the Confederate Army from its base.

The Confederates possessed some very obvious advantages: their leadership was superior, at least until 1863; they had the benefit of conscription after the first year; they held the interior lines. If, added to these, they could have enjoyed equal munitionment from the beginning, there is much to buttress a contention that they could have sustained themselves. They improvised to an astounding degree, and their captures of material were very helpful; but their guns and artillery ammunition were never equal to the Federal artillery, and eventually their horse equipment and personal equipment of the individual soldier became woefully deficient.

IT IS most impressive to observe how the experiences of the Civil War foreshadowed certain events of the World War. At Spotsylvania, Cold Harbor and Franklin we see the offensive checkmated when it encounters veteran infantry, armed with modern rifles, behind breastworks. At Petersburg we see the foreshadowing of the stalemate of trench warfare.

Our own Civil War furnishes one of the best fields of study for American military students: the best accounts of its various phases are in English; it was entirely fought by our own people, and the elements of strength and weakness are, therefore, national characteristics which might again be encountered. The average intelligence and mental alertness of the combatants on both sides were remarkably high, and these qualities are bound to be reflected in the discussion of events and experiences. Finally, these discussions have the very great value, in many instances, of proceeding from veterans who never became professional soldiers and so always retained the fresh viewpoint of civilians.

The wisdom, often so dogmatically expressed, of the easy-chair critic, has done much to discredit even the considered views of well informed civilians. This is a natural albeit most unfortunate reaction. It is becoming increasingly important that civilians interest themselves seriously in the military problems of their countries. The intense and all-absorbing nature of war, as we now understand it, demands this. No professional service, however well trained or devoted, can now carry the national load.

While civilians must assist, our salvation reposes on our professional services. The history of modern nations seems to prove that greater resistance to progress has usually developed within the military services than has been experienced without. Order is heaven's first law, we are told; and the "established order" is an admired, if not a sacred, institution in most services. Add to this conservatism the love we all develop for the particular branch in which we serve, and we find an area of resistance so well fortified with strong points that it is no wonder the advance lags.

The technique and mechanics of war are inseparably related to the technique of peace. So true is this that it is often difficult to separate cause and effect and determine precisely whether the demands of war created a certain mechanical advance or whether the advances of peace made possible certain mechanics of war. Without involving ourselves in the detail of this phase of our subject, we may accept and emphasize the principle that the General Staff and the procurement departments should be alert to obtain every advantage possible from advances in peacetime technique. It is the tendency of most nations to overstress manpower and to overlook mechanical military opportunities until the strain and demands of war force recognition.

IT IS popular in certain quarters to attribute to the dullness, obstinacy and general wrong-headedness of the military higher-ups, any failure of the regular services to keep the art of war fully abreast of the technique of peace. Every one outside of the services, from the least informed civilian to the highest placed statesman, blandly ignores the obvious fact that experimentation and progress mean expenditure; and that only by the liberal use of money can the services be kept up-to-date in the mechanics of war. Confine in expenditure for experimentation, as we do our Army and Navy, any of our great industrial concerns such as the American Telephone & Telegraph Company, the General Electric Company, or the Westinghouse Electric Company, and see how long they can maintain their ascendency in their respective fields. Yet, must we not admit the tendency in the services to permit expenditures for routine items that a wiser discrimination would direct into channels of research or experimentation? See Robertson's "From Private to Field Marshal" for evidence of inability to obtain an appropriation of a few hundred pounds for experimentation with bombs in infantry-training in the British Army, although we may be sure that many times that amount was going into brass polish or some other similar item that represented pomp and circumstance.

And this allows just the chance for us to emphasize again that interdependability of the departments which should eliminate all complacency in one at authority for unnecessary items while another goes short of necessities for the need of which the entire service and the entire nation must some day pay in misery and humiliation.

It must be our study, during peace, to learn to utilize for war those elements of power in which we are likely to be superior to all potential enemies. As we are the strongest nation in the world industrially, indeed in metals, machine tools, and horse-power the equal of all the rest of the world, mechanized war should find us the strongest. But it would be fatal to overlook the fact that the mechanization of war increases the importance of the time element in preparation. Therefore, our study must include the means by which we could speed up production.

EVEN those among us who believe in the mechanization of war must recognize the possibility of mechanizing it beyond the ability of any available personnel in time of war to use the machinery to the limit of its possibilities. As a matter of fact, have not the nations already accomplished just that with the latest rifles? The military rifle has become a piece of scientific equipment developed beyond the capacity of the majority of infantrymen and, therefore, more costly and less serviceable than a simpler piece. There must always be a just balance between the laboratory equipment of the expert and the field equipment of the soldier. Neither Europe nor our own country affords many opportunities for an unbroken field of fire of one thousand yards for infantry, yet we as ardently favor a rifle with a range three times that length as if the exact reverse were the fact.

The subject of small arms is one which, of course, should be treated by itself. I am only glancing toward it. But this you may write down in the book: The Great War gave few, if any, opportunities to use the long range capacity of the rifle. In our Civil War, four hundred yards was a long field of fire, and in the World War, under European conditions, a six-hundred-yard field of fire was very rare.

All former wars of the English-speaking nations have, in their beginnings, witnessed periods of improvisation. The advancing technique of war lessens the chance of successful improvisation, so that the probabilities of initial success increasingly lie with the prepared nation. Of course, initial success does not always mean final success; improvisation must still play a part; but every increase in technical requirements, in whatever piece of equipment or branch of the service, automatically adds to our time load and increases responsibility for developing plans and methods for quick production.

This, and any other, general discussion of munitionment

must assume a basis of something approaching industrial equality between warring powers. As between an industralized nation—England for example—and an unindustralized state, the difference might approach that which would correspond to an unarmed man and an armed policeman who was also his physical superior.

As it is not the purpose to make this occasion the detonating point of another world war, no discussion will be indulged in as to military race superiority. Indeed, no expression of opinion on that delicate question will be ventured beyond the declaration that there is no such thing. Every race and nation, if we may trust history, has had its share of victory and done its share of "retiring according to plan."

The surest way to establish racial or national military supremacy is to be superior to the enemy in armament, or leadership, or training or knowledge of the terrain; or in three or all four of these desiderata. Consequently, it is necessary for even a superior race like ours to give attention to the subjects of preparedness and munitionment.

Neither would it help us here to become involved in a discussion of mechanical warfare versus the increase of fire by strengthening the firing line. It is a well-known principle in mechanics that when a certain degree of efficiency has been attained by a given method, further progress must be sought by a change of process. Therefore, revolve these figures, and speculate on their significance. According to Sir George Aston: "Between noon on September 28 and the same hour on September 29, 1918, nearly 944,000 rounds, costing nearly £3,900,000, were fired from British guns on the Western Front."

Consider that this volume of fire represents four years of intensive preparation by one of the greatest industrial nations of the world, reinforced by the productive power of its colonies and a considerable percentage of the manufacturing power of the greatest metal-working nation on earth—the United States. It points the probability that advance in fire power cannot be looked for by increase in volume developed through munitionment. It, therefore, must be sought by improvement in character.

This is the basis for the opinion now frequently expressed that, in the next great war, mechanization and chemicals will, relatively, play a much larger part. There is growing opinion that gunfire of all kinds has about reached its zenith; that we have traveled as far as that road leads.

It is this principle of change which makes our problem of munitionment at once so difficult and so interesting. It can never be static. We work out new designs; produce the article; issue it to the services, and almost before the field trials can be made it has begun to develop elements of obsolescence.

In this fact, however, lies one of America's strongest elements as a military nation: we are adaptable, and our mechanical adaptability at this time is unequalled.

THE volumes recently published in England—"The Mechanization of War," by Victor Wallace Germains, and "The Remaking of Modern Armies," by Capt. B. H. Liddell Hart—contain much that is interesting, and some elements that are inspirational. But each writer impresses one as over-anxious to win for his side. The mechanization of war is proceeding just as certainly as the mechanization of the peaceful world. To question that is to step outside the lists of those entitled to opinion. The subject then becomes one for scientific inquiry, and the final decisions must rest with the leaders who we hope will be capable of recognizing and utilizing every possible advantage. To allow the discussion to assume any aspects of a joint debate, in which the decision may repose on eloquence or the clever use of advantages solely verbal, would be both unworthy and unwise.

As to our own nation, there are three phases of preparation to which we can and are likely to devote our energies. One is mere discussion, which stimulates inquiry, study and thought and thereby fits us somewhat for an emergency, but otherwise accomplishes no great purpose.

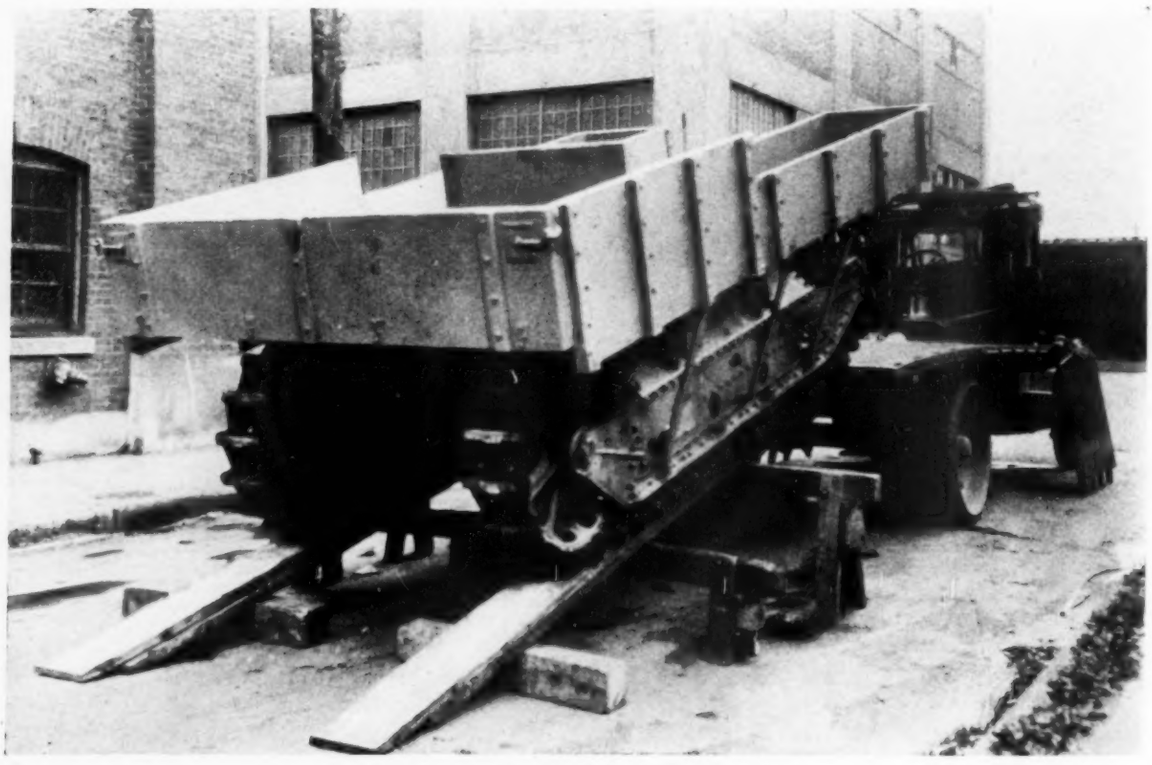
The next and considerably more valuable phase would be the general, even though uncoördinated and unpointed, organization and education of our industries to undertake a production program if and when needed.

The third, and the one every good citizen would desire, could he visualize the problem, would be a national program of mobilization worked out on true military principles and applied to our national potentialities in men and resources. And in this program the industrial resources would receive at least equal attention with manpower.

This would cost a little money (a trifle compared with the loss we shall some day suffer if we fail to do it); and it would assure that all movement would be forward and every year advance us on the road to such potential military strength as to make most improbable the chance that we should ever have to use it.

THE NEW LIGHT TANK

The New Light Tank, M1
This "job" represents the maximum fire power of the light type of tanks. It has an all-purpose chassis on which several styles of body may be mounted.



Light Cross-Country Cargo Carrier, T1
This is the same chassis as that used in the Light Tank, M1. The tank superstructure is removed and replaced with a cargo body of one to three tons capacity.

Automotive Equipment of the Army

By Maj. Levin H. Campbell, Jr.,* Ord. Dept., U. S. A.

IN THE time which has elapsed since the Armistice, the leading military authorities of our Army have been giving serious study to methods and means of transportation for our armed forces. War has become so largely a matter of the use of machines, and the expenditure of ammunition by all weapons has been so greatly increased, that the rate of movement of an army is practically set by its ability to move its equipment. The horse, while a most dependable form of transport, does not possess either the power or the rate of speed desirable in a modern army. For these, and other reasons, the trend of thought is tending more and more to the use of motor-propelled vehicles of all types, and the purpose of this article is to set forth briefly the development work which has been done by the Ordnance Department since the Armistice toward carrying out the duties with which it is charged in the matter of developing vehicles which are adapted to operate primarily off the roads.

FOREWORD

Motorization and mechanization are of greatest importance in the securing of modern-day mobility for the Army. This article by Major Campbell is of interest in setting forth what has been done toward that end, and his views, as expressed, may be taken as representing those of the Ordnance Department.

It is a pleasure for me to take this opportunity of expressing my personal appreciation for the unfailing help in our problems which has been extended at all times by the automotive industry of America.

MAJOR GENERAL,
CHIEF OF ORDNANCE, U. S. A.

In all its work, the effort of the Ordnance Department is to produce what the using services want. The designs are based entirely upon the requirements of the "customer," and the words "serviceability" and "reliability" are ever uppermost in our minds.

Unfortunately, lack of funds has resulted in little opportunity for the using services to work with modern automotive equipment. Their ideas of performance and dependability are based largely on familiarity with vehicles of 1917 and, if they look askance on the idea of motorization, it is not surprising. Their yardstick of performance of motorized equipment is the old six-ton tank and the old types of trucks. Trucks and tractors that give many miles of service with but a reasonable amount of upkeep and repair are commercially available in large quantities. The mileage life of special automotive vehicles, such as the tank, is being increased constantly.

All development and improvements are based largely upon manufacture of units in quantity, with tests under every conceivable condition of operation. The commercial industry each year manufactures automotive vehicles in the thousands and millions; the Ordnance Department builds by single units when funds are available. By the end of the present fiscal year we shall have built (not manufactured) a total of seven tanks. The engineer can usually evolve a good design, but to gain that last few per cent. so necessary to reliability we must build and test, build and refine, build and perfect. If at times we and our "customers" become discouraged and feel that our progress is slow, let us not forget the fact that we are working "under wraps."

Such remarkable progress has been made in the past decade, and is being made from year to year in automotive design, that the engineer wonders at the retention of animal-drawn transportation in the Army. He feels that, with the enormous automotive production facilities in our country, our Army should be in a most favored position. He knows that this is an age of motorization, of high-speed transportation; and he firmly believes that he has built and will continue to build such reliability and performance into his vehicles that the Army will, as business has done, motorize. We shall still use the horse, but the motor will steadily circumscribe his usefulness.

The entry of the Ordnance Department into the field of automotive design dates from 1917. Shortly before that time the Artillery had tested some few commercial tractors, and a small number of armored cars, built on commercial truck chassis, had been produced experimentally for use with the Cavalry. Let us see where we stand today.

AT THE time of our entry into the World War, the subject of tanks was an entirely new one to the Ordnance Department, and our war-time designs were largely British and French ones adapted to our manufacturing standards. The tanks thus produced were the Mark VIII and the six-ton Renault.

The Mark VIII, of which 100 were completed after the Armistice, weighs 40 tons and is driven by a modified Liberty aircraft engine at a speed of five miles per hour. A crew of 12 men operates the tank and mans two 6-pounder guns and seven machine guns. The armor protection is from 6- to 16-mm. thick. The great length of the vehicle gives it maximum ability in crossing trenches. Its size, however, makes it an easy target and decreases its mobility. Speed is obviously one of the best protections a tank can have against hostile fire. The present trend of design is toward lighter and much faster tanks.

The six-ton Renault tank was produced in large numbers in this country for use in the World War. It falls short of meeting the requirements for a light tank, for it

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The 40-Ton, Mark VIII, Tank
The heavy, slow vehicle of World War days. Present trends are toward lighter and faster tanks.

is mechanically unreliable and its speed is only six miles per hour. The crew is composed of a driver and a gunner protected by armor that varies in thickness from .25 to .6 of an inch. The armament, either a 37-mm. gun or a caliber .30 machine gun, is mounted in a turret that has a 360-degree traverse.

The Ford two-man tank represents one of many attempts that the Ordnance Department made during the war to collaborate with the commercial industry in the production of tanks. Some few of these were built during the war, but the Armistice was declared before quantity production was inaugurated.

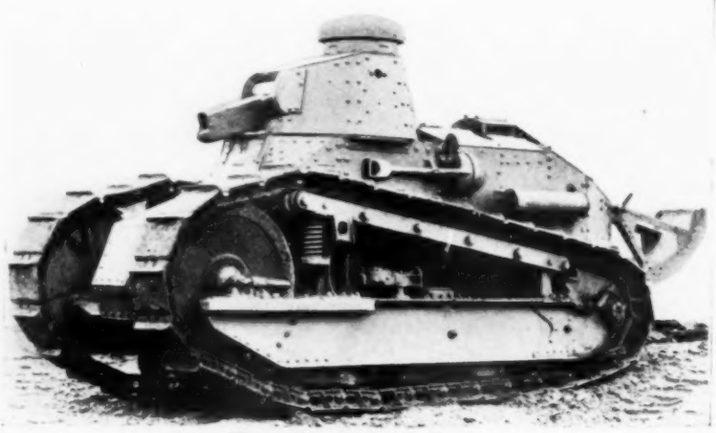
The experience with these three tanks emphasizes the fact that mechanical reliability results only from carefully thought out designs later perfected after tests. Each of these tanks is a remarkably good product when we consider that they were all designed during the stress and hurry of war, and that little or no development and test work was done before quantity production was entered upon.

After the Armistice, General Pershing appointed a board of officers, now known as the "Caliber Board," for the purpose of recommending ideal types of Army Ordnance equipment on which development work should proceed. One of the recommendations of the board was for the development of a medium-weight, high-speed tank.

The 23-Ton Tank T1, now undergoing test by the Tank Board, is the third of this type built and incorporates the improvements found necessary in the tests of the first two. The speed is 12 miles per hour; the armor is 1 inch thick over the fighting compartment; and the armament is one 6-pounder gun and one caliber .30 machine gun in the lower turret, with one caliber .30 machine gun in the upper turret. The crew consists of a driver, a gunner, a loader and a tank commander who also fires the upper machine gun. This tank is mechanically good and appears to be well received by the Tank Corps as a fighting machine.

We feel, however, that we can produce a tank of 12 to 15 tons weight having equal or greater fire power. This vehicle would be much "quicker on its feet" and would present a much smaller target. Trench-crossing ability is a function of length, but length means weight. Weight means more engine power, which immediately calls for a repetition of "the vicious cycle" of more weight. It is obviously impossible to armor against all calibers of guns unless we build "land battleships," such as would undoubtedly make their appearance in any protracted stabilized combat situation. These "ships" conceivably would carry large numbers of machine gunners to occupy the ground gained. Thus all design is of necessity a compromise of factors desirable and undesirable. We feel that we should constantly strive for speed and fire power, with the maximum armor protection consistent with reasonable weight.

THE most interesting tank we have is the Light Tank M1. An experimental model has been completed and given an extensive test. Its remarkable mechanical performance has resulted in an enthusiastic reception of the "job," and its fire power is the maximum obtainable in that weight of vehicle. The speed is 18 miles per hour, and the cruising radius on the gasoline carried is 80 miles. The crew—a driver and a gunner—is protected against the service rifle bullet at all ranges. In the all-round fire turret are mounted both a 37-mm. gun and a caliber .30 machine gun, with a fully adequate supply of ammunition. The mount for the guns provides for a limited traverse independent of the turret traverse, and for ample depression and elevation. The fighting compartment is completely ventilated, which for the first time insures comfort for the personnel. The mechanical control and operation are of the simplest. The commercial Cunningham engine pro-



The 6-Ton, Renault Tank
This vehicle of 1918 design does not meet requirements of a light tank today. It is mechanically unreliable and too slow.

vides ample power for any kind of terrain, and the speed of tanks over rough ground depends largely on the ability of the crew to stand punishment.

A few—four more—of these tanks are now building and will go to the service for test so that we may have the advantage of suggestions and helpful criticisms in this development. As soon as funds can be secured, at least a battalion of these light tanks should be placed in the service for tactical tests, as obviously much will have to be worked out in the correct employment of these high-speed, high-fire-power little machines. They are a "different breed of cats" from the old six-tonner.

One of the most interesting features in the design of the Light Tank M1 is that it is built on a basic, all-purpose chassis. This chassis may be likened to an automobile chassis on which may be mounted several different styles of bodies. One of the service demands that has been most perplexing to us is for a cargo carrier to follow the tanks with oil, gas, water, spare parts, tools and the like. It was to meet this very real requirement, and hold to a minimum the number of special vehicles to be produced in war, that the all-purpose chassis was evolved.

The illustration shows the chassis with tank superstructure replaced with a cargo body of a capacity of from two to three tons. The model is of wood, but might as well be of steel. This body may be of a wide variety of types. We have in mind a platform body for mounting large wire reels for the Signal Corps; a similar body to carry a balloon winch for the Air Corps; a stake body for engineer equipment; a tank body for water and gasoline; a light, armored body for carrying personnel, and so on. As a light, fast tractor for loads up to six tons, this unit is without a peer today. The chassis is truly an all-purpose one, and is a good production proposition with a greatly simplified maintenance as regards spare and replacement parts for the field. Even so, it represents only a good start. Much remains to be done to perfect the vehicle, and we need not only funds, but the "litmus test" of service use of a number of these tanks.

The Ford Two-Man Tank

One of many attempts of the Ordnance Department to collaborate with commercial industry during the World War.

ONE of our dreams of several years' standing (in which the British have "scooped" us) is the design of a light, fast and small armored conveyance for getting the individual over a fire-swept zone with some protection other than his skin, and with the means for maximum fire power, which is the machine gun, with him. The conveyance—call it tank or whatever you will—will carry but one man, who will drive with his feet and thus have his hands free to operate his gun. If he should wish to leave the vehicle, a pull on a pin releases the machine gun, which he may then set up on its tripod. This little tank will present only a small target, its speed will be high, and we shall at last have a highly mobile, armored machine gun.

We may expect war-time losses in tanks to be high, but if a wise policy has given us enough of these machines, they will accomplish their mission. But it is also possible that the losses may not be so great, for the Chemical Warfare Service has recently evolved a smoke-producing apparatus for the tanks which may find favor with the Infantry. The use of tanks will enormously reduce the battle losses, and their early and continued employment will assure a war of movement to the side that has them in quantities.

Medium Tank, 23-Ton, T1

The medium weight, high speed fighting machine which incorporates latest improvements in its type of vehicle.

OUR first efforts to produce a fast vehicle for reconnaissance work resulted in a Ford car with two additional dead axles, and a fabric belt track over and around all wheels. It would cross almost anything, but its life was woefully short, due to additional tractive resistence. We also tried several special designs of our own with but indifferent success.

The latest type of cross-country car is a standard Chevrolet or Ford chassis, equipped with oversize balloons and light bucket seats. Some of us feel that the car has become too heavy for best results, and it is in our minds to try to bring the weight down nearer to the original car we turned out in 1923.

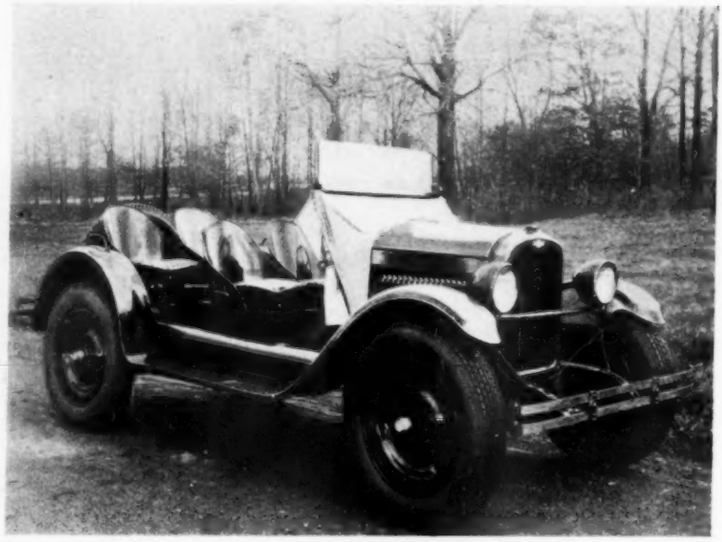
The purpose of the light cross-country car is partially to supplant the motorcycle, to carry reconnaissance parties, to supplement the horse and replace him where possible. A small box,

or a wire reel, may be substituted for the rear seats. The performance of the cars across country and soft ground is excellent. Their reliability needs no comment.

AMONG the cross-country cargo carriers are several different types of vehicles: trucks, trailers, self-propelled cargo carriers, and power carts.

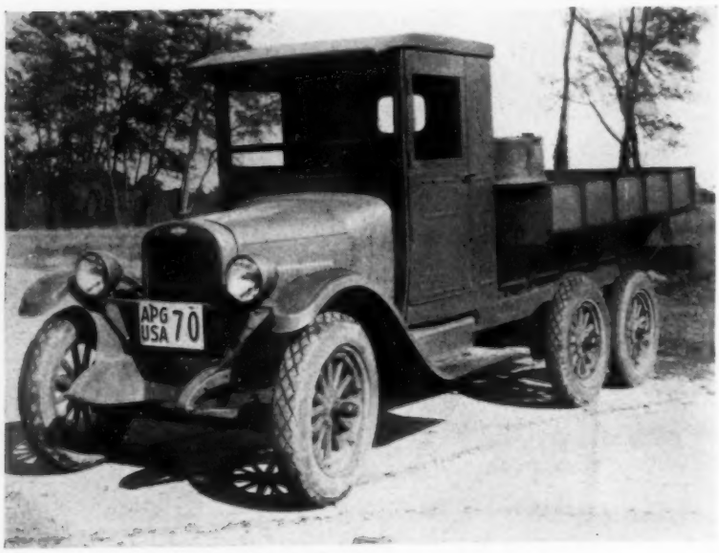
The ability of any vehicle to move over soft ground is primarily a function of unit ground pressure, and varies inversely therewith. Other factors, such as ground clearance, gear reduction, and the like also enter, but unit ground pressure is paramount.

The standard Chevrolet one-ton truck has been equipped with balloon tires and an extra driven axle, with the idea of lessening unit ground pressure and increasing "mud ability."



The Cross-Country Car

The latest type of cross-country car is a standard Chevrolet or Ford chassis equipped with over-size balloon tires and bucket seats.



Cross-Country Cargo Carrier

The standard Chevrolet one-ton truck with balloon tires and an extra driven axle. The body seats five men or carries cargo to one ton capacity.

We are about to turn out another with the largest tires the standard wheel will carry. The additional axle adds but little complications of design and delay in production. The body is our design, and comfortably seats five men on a side, or carries a load up to the rated capacity of the chassis.

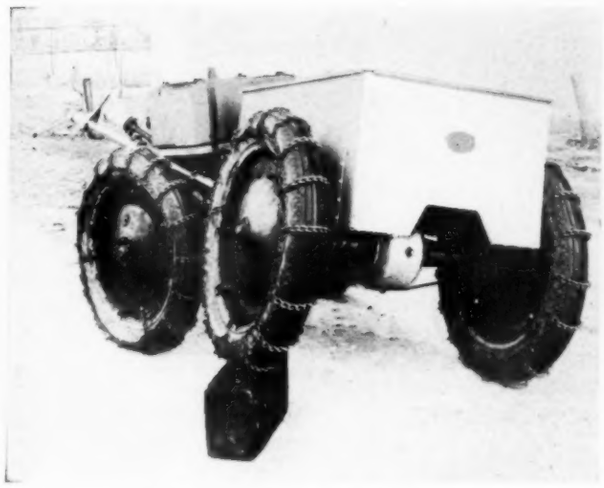
For cross-country work, a light truck is much better than a heavy one, because a squad of men can extricate it fairly easily if necessary. Heavy trucks that have to stick to roads could operate to "truck heads" (similar to rail heads), from which the light trucks or track-laying cargo carriers could operate.

It should be accepted as axiomatic that no round-wheel vehicle is the equal of the track-laying type in negotiating "bad going." The round wheeler, on the other hand, is much more mobile on roads and hard ground, its mileage life is much greater and the maintenance problem is far simpler. The truck is more of a "fair-weather sailor" than the track machine, and only by a service test under field conditions can the Army determine the proper uses of each in our organization.

Several different types of track adapter for use on heavy trucks have been tested at our proving ground within the past six years. A typical one is the 5-ton Mack truck with the rear wheels replaced by a Christie track mechanism. Forgetting for the moment the relatively short life of any adapter so far tested by us at speeds considered necessary by the Army, the big and insurmountable fact remains that the truck is designed to drive a round wheel, and not a track machine with its greatly in-

Mack Truck with Christie Adapter

One of several types of track adapter tested by the Ordnance Department. This is the 5-ton Mack truck using the Christie track mechanism.



Wheeled Power Cart, Model 1924 E

A four-wheel-drive, balloon-tired cart driven by an air-cooled motorcycle engine. Articulation between the axles permits the wheels to follow unequalities of the ground.

Mark VII Motor Carriage for 75-mm. Gun

The motive power is a Cadillac motor car engine which gives a speed of 15 miles an hour. This unit can serve both as an accompanying gun and for an artillery reserve.

creased tractive resistance. In other words, to drive a track-laying machine, the engine and power transmission units must be built for that purpose, or failures result.

I do not believe that we have overlooked anything in our efforts to test all promising ideas, whether presented in this country or abroad. Adapters with steel tracks, wire tracks, fabric tracks, and rubber tracks have all had a full and impartial trial.

Several types of caterpillar track trailers have been built and tested, but the trend is decidedly toward the wheeled vehicle. The complications of a track mechanism and its limited road mobility outweigh its advantages for cross-country operation. Probably the ideal trailer is of the wheel type with a smooth underbody for sledding in deep mud. If it is towed by a tractor of proper power, it will perform up to any reasonable expectation or demand. Many excellent wheeled trailers are available in the commercial market. With relatively minor modifications they will meet adequately the severe requirements of the military service.

A few self-propelled track-laying cargo carriers were built and tested, and, even though underpowered, were fairly successful and served to prove the entire practicability of the idea. The light cargo carrier on the all-purpose light tank chassis will meet, we feel, the requirements for this class of transport.

In our next design of a medium tank, we are going to try to provide a chassis for the carrying of greater loads, probably six to seven tons. This heavier vehicle will have the same wide range of useful service as the light cargo carrier.

THE Caliber Board brought out the idea of a light weight power-driven cart able to operate over soft ground, and to have a pay-load rating of 450 pounds. Several of the track-laying type were built, but the exacting limitations in weight to permit of "manhandling" made it impossible to build the necessary mileage life into them. Next came a four-wheel drive, balloon-tired cart. An air-cooled motorcycle engine drives this cart at a speed of four and a half miles per hour. Articulation between the front and rear axles allows all the wheels to follow inequalities of the ground, and gives excellent tractive ability. Steering is done by varying the angle between the two axles. While the performance of this model has been fairly satisfactory, the thought is now that we should endeavor to develop a light armored, track-laying vehicle capable of transporting three men with a Browning machine gun, and necessary ammunition, for advancing across fire-swept areas. Such a vehicle will no doubt be far better than the wheeled power cart just described, in cutting down the battle losses.

AS IS quite generally known, the Ordnance Department, working in collaboration with a commercial manufacturer, during the war designed the five and ten-ton tractors, model 1917, of which large numbers were built for towing corps and army artillery, respectively. It is of particular interest to know that, even though the five-ton tractor was designed and built in but seven weeks, none of the vehicles reached France until the summer of 1918. From the building of a pilot model to quantity production is a long step.

The Caliber Board recommended the development of fast tractors for the division, the corps and the army. In the three years following the Armistice, satisfactory types of each were developed, and the drawings are available. In the design of special vehicles, the Army is always faced with the problem of keeping them up to date. Funds are seldom, if ever, available, and therefore, our machines become obsolete in mechanical type and in performance.

The delay of putting any sizeable mechanical construction into quantity production requires little elaboration here.

With these facts, and the heart breaking production experiences of the World War in mind, the wise policy has been adopted of depending upon the commercial industry for the supply of tractors for the Army. While these tractors are not in all respects ideal for military uses, competition assures that they always represent the latest in the automotive art. In time of emergency, factory production can be augmented to meet our schedule of requirements. Each year, as funds permit, the department tests

a few tractors so that we may keep fully informed as to available and suitable types. This applies both to track-laying and wheeled vehicles, such as the Fordson, McCormick-Deering, Topp-Stewart, and others.

Various track adapters and "trick" wheels have been tried out with wheeled tractors Also there has been a test of at least one foreign-made tractor. In addition, there are being brought to our attention constantly, tractors that are found to be not suitable for our service, and which, therefore, do not reach our proving ground.

Our standard tractors are now the Caterpillar two-ton, the Caterpillar "20," the Caterpillar "30" (five tons) and the Caterpillar "60" (ten tons), products of the Caterpillar Tractor Co. Under military service conditions, each of the tractors will handle satisfactorily a load equal to its own weight. They may also be "doubleheaded." The rate of march is about four miles per hour, but by substituting high speed gears is increased to eight miles per hour. Such speeding up of units, not especially designed for high speed, gives materially shorter mileage life.

A MOTOR carriage is, in effect, a high-speed, track-laying tractor which mounts a gun or howitzer for transport and firing. Highly satisfactory types have been brought out for division, corps, and army use, but this line of endeavor is now dormant, due largely to lack of funds. We feel, however, that the motor carriage has a future, and that some day it will come into its own. The thought of moving across country a division gun at fifteen miles per hour, or a corps or any army gun at ten miles per hour and emplacing any one of them in less time than it takes to determine the firing data is a most alluring one.

Of particular interest is the division motor carriage, mounting the 75-mm. gun. The motive power is a Cadillac motor car engine, which gives a high speed of fifteen miles per hour. To put the vehicle into firing position, the brakes are set, the outriggers or struts at the rear of the tractor are quickly lowered to the ground by pulling a pin, and the mount is ready to fire. This unit, provided with suitable armored shields is of use as an accompanying gun in an advance and also provides a highly mobile unit for an artillery reserve.

Of course, all of the old arguments may be brought out—"all the eggs in one basket," "the gun is useless if the tractor breaks down," "the tractor stands idle when the gun is in place," and so on. But again, I dare the prediction that the motor carriage will eventually have its place in our organization. Ammunition will be supplied by the light cross-country cargo carriers operating at the speed of the motor carriage.

A committee of eminent engineers of the Society of Automotive Engineers, has, since 1919, been of inestimable value to us. All of our automotive projects have been submitted to its members at biennial meetings, held usually at some great plant of the industry. We have received constructive criticism and helpful advice, and we have been given access to the latest developments in the art. We give grateful acknowledgement to this group of patriotic citizens who serve us entirely without remuneration. The gentlemen who have served on this committee are well known in the automotive industry. It is a pleasure to list their names herein: H. W. Alden, B. B. Bachman, W. L. Batt, David Beecraft, C. F. Clarkson, G. W. Dunham, Geo. A. Green, A. W. Herrington, P. E. Holt, C. F. Kettering, C. M. Manly, A. F. Masury, Dent Parrett, D. G. Roos, G. A. Round, Wm. Turnbull and W. G. Wall. We have also been fortunate in the type of automotive engineers who came into our service during the war, some of the best of whom have remained.

Surely no one can fail to realize that we are in an age of mechanical transportation. All commercial industry is adopting motor transport in ever increasing proportion. Our reports from abroad indicate that other armies are tending much more strongly toward motorization than we are. This country possesses an automotive industry greater by far than all the rest of the world combined, and our Army must, and will, take full advantage of our favored position.

The Ordnance Department and various service boards have made complete mechanical and performance tests of many motor vehicles. As new models come out, they will be handled similarly Enough data have been accumulated, and it is now in order to take the next logical step. Motorization, or mechanization as we call it, involves much more than merely putting a tractor in the place of a team of mules, or a truck in that of an escort wagon. It involves working out an organization built around motor transport; an organization that has great mobility; an organization that has fewer men. Mass is the foe of mobility. In other words, we shall eventually have to work out a complete reorganization based upon modern transportation methods.

Further mechanical tests of one or two machines will now serve no such purpose; motorization is now a problem for the combatant branches to work out. With this end in view the Secretary of War has ordered the assembly of a small force of all arms at Fort Leonard Wood, Maryland, during the coming summer, which force is to be equipped entirely with motor transportation, trucks, tractors, tanks, armored cars, etc. This force will be organized and will operate as a mechanized unit. Effort will be made to work out suitable tactics for the employment of the force so that it may be fitted into the organization of the Army in its proper relation to the whole. Unfortunately, the force will be largely equipped with automotive vehicles of war-time design which will preclude, at least in part, obtaining a correct picture of the capabilities of such a force were it equipped with modern vehicles. However, it is a start in the right direction, and when funds are available for the supply of new equipment the full possibilities of such a force will become apparent.

The vehicles described in this article represent types only, and in every case, the laborious work of reaching production remains for the future. Financial considerations make it impossible in time of peace to manufacture and store large quantities of such equipment, as it would soon become obsolete. What we hope, however, is that funds will be made available for experimental and development work to continue so that we can keep abreast of the art. It is not the purpose of this article to trot out the grand old American eagle for another scream, but rather to present the accomplishments of our modest development program since the War.

Progress in the Standardization of Ordnance

By Col. W. H. Tschappat,* Ord. Dept., U. S. A.

BEFORE outlining the progress in the standardization of articles supplied to the Army by the Ordnance Department, I will briefly review the commercial movement for standardization. It will be found that the ultimate purpose of commercial standardization is to facilitate and cheapen the supply of articles to the buying public, an object which does not differ greatly from that of the standardization of military articles.

Col. W. H. Tschappat, Ord. Dept., U. S. A.

Before an article can be standardized the use to be made of it must be clearly understood. Usually the need for a tool, machine or other mechanical contrivance comes to light through experience in the use of a similar device already in existence. The new device is intended to overcome defects in the old one or to meet requirements not considered when the old one was designed or to be capable of production at a lower cost. In the design of an article intended to perform certain functions it is, therefore, absolutely necessary that the designer have a clear knowledge of these functions. A clear statement of the functions which the article is to perform and the manner of performance may be called a list of performance specifications of the article. Such a list must always be set up by or for the designer to insure that the new article shall meet all the requirements. For the most important of the items on the list the designer will go directly or indirectly to the users of the article, but it will usually be necessary for him to list and coördinate certain requirements in which the user has no direct interest, but which nevertheless have an important bearing on the commercial or economic success of the article.

Now, even if the performance specifications are laid out for an article to perform very simple functions, they usually may be met by a wide variety of articles. Requirements for a machine to perform complicated functions, as for instance an automobile or a gun carriage, may be met by a still wider variety of designs if all details are considered, but it is also true that complicated performance specifications may actually limit the number of possible designs as to main features. One object of commercial standardization is to limit the number of different kinds and sizes of articles to perform a given function, thus reducing the number of articles that must be carried in stock and simplifying designs involving use of standardized articles.

STANDARDIZATION of mechanical articles was first undertaken in this country by manufacturers who found it necessary to simplify their products and methods of manufacture to get a market established. Later, the engineering socities drew up standard specifications for raw and finished material from the point of view of the users, or that of the manufacturers of more highly developed products. Standardization of details such as establishment of definite numbers of diameters of bolts, wire, bolt holes, thickness of plates, diameters and other dimensions of bar stock were among the first steps taken. Similarly, standards of chemical and physical qualities of metals were definitely established. The American Society for Testing Materials and other organizations established standard methods of testing and inspection to determine whether qualities agreed upon between purchaser and producer were being met.

During the World War the need was felt for coördination among the organizations setting up standards and as a result the American Engineering Standards Committee was organized in 1917 and 1918 by a meeting of a special committee consisting of representatives of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Society for Testing Materials, which were among the largest organizations then engaged in the promulgation of specifications. In 1919 U. S. Government representatives of the War, Navy and Commerce Departments were added to the membership, and later other na-

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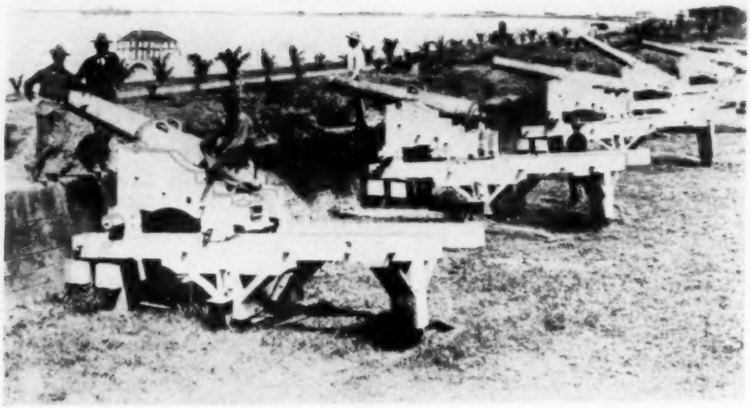
tional bodies besides those named were admitted to representation. The object of the Committee is to permit the systematic coördination of standards among all the interested organizations concerned before their adoption by any one organization, thus making possible the achievement of real national standards. The Ordnance Department has representatives on several of the sectional committees of this organization.



Standard Ordnance of Another Age
Old brass cannon captured from the Spaniards in 1898, Manila, P. I.

Webster's International Dictionary has the fifth of its nineteen definitions of the noun "standard" as "that which is established by authority, custom or general consent as a model or example." It defines the adjective "standard" as "being, affording or according with a standard for comparison or judgment." The applicable definition given of the word "standardize" is "to reduce to or compare with a standard; to render standard." It is well known that the definitions of all words tend to change and grow as time goes on; that both of these words have had a particularly varied career and each of them is now used in commercial and military parlance with a meaning differing to some extent from any of those given in the dictionary definition.

The commercial definition of a standard article is one which is being produced and marketed in quantity. Such an article frequently remains the same year after year. It has established its market and only the marketing of a superior or more salable article by a competitor may influence a manufacturer to change his design or specifications. However, modern, up-to-date manufacturers have in reserve in anticipation of the marketing of superior articles by their competitors, designs and specifications for changes in their own articles intended to meet new competition by a superior article or by one which appeals to the buying public. Sometimes it is necessary to put such an article on the market to meet competition, but these do not necessarily entirely replace production of the old standard article but rather add a new standard. As examples of articles which have been on the market for a long time without any change in specifications may be mentioned Ivory Soap, placed on the market by Proctor and Gamble of Cincinnati in 1840, or thereabouts. Oliver Chilled Plows are the same as they were forty or more years ago. The transportation business is one in which rapid advances have been made for the period within our memory, yet the general designs of street cars have not changed much in the last twenty years, and changes are just beginning to be forced by the competition of new forms of transportation. Many examples could be mentioned of the stability of standards once established and the disinclination to change even though defects, as the noise of street cars, are well recognized.

The most notable recent examples of frequent changes in design in commercial articles are in the automobile and radio. In the former, however, this is more apparent than real, as annual changes in standard makes of automobiles in recent years have been limited to changes of detail and do not include changes in the main design unless such a change is forced by some new development as was the case when balloon tires and four-wheel brakes were brought out. Both of these articles are examples comparatively new in commercial production and changes will doubtless become fewer and fewer.

EXPERIENCE in the World War convinced the War Department of the absolute necessity of standardizing equipment so as to reduce the number of articles to a minimum and to make available the best of each class, and also of the desirability of having available at all times standard procurement specifications for each article of equipment. The War Department thus naturally joined the commercial standardization movement. Its policy on standardization is outlined in Army Regulations 850-25, draft of which was first gotten out in 1919 and which has been revised from time to time.

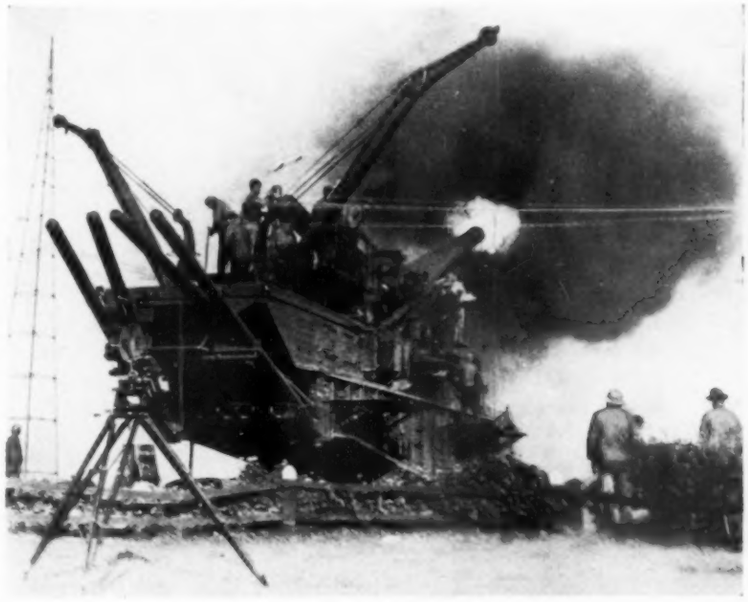
The War Department definition of standard articles, as quoted from Army Regulations 850-25, is "standard articles are the most advanced and satisfactory that have been adopted and are those which are preferred for procurement to meet supply demands not met by the issue of available adopted types." In other words, they are the best developed types, but they may not have been in the hands of users to any appreciable extent. In the Army the nearest practicable approach to the ideal is made standard while the commercial standard is the article which is actually made and marketed in the greatest quantity.

The same army regulation outlines in detail the procedure in the standardization of new types of equipment for the Army. First, there is set up the machinery for doing this consisting of the War Department Technical Committee and the Supply Branch Technical Committees. There is quoted the paragraph of this regulation which states the responsibility of the representatives of the other branches on this technical committee. It is as follows: "The technical committee will consist of such representa-

tives as may be detailed by the chief of branch and of a representative from each of the other supply and combatant branches. The latter are designated by the chiefs of branches, the purpose of this representation being to effect coördination of the work of the branch technical committees with the views of chiefs of other interested branches." On the Ordnance Technical Committee and subcommittees thereof, we look to the representatives of the other branches to present the views of their chiefs, and similarly our representatives on other branch technical committees should present the views of the Chief of Ordnance. Next, the various steps leading to standardization are outlined.

(1st) Setting up of requirements of types of equipment. There may be demands for entirely new types of equipment to meet new needs or there may be demands for improved articles to meet needs previously existant. The setting up of requirements of types is a function of the War Department, exercised through the General Staff, which must finally approve requirements of types, but recommendation concerning them may be made by any branch or individual. Required types are set up through performance specifications which list the features the article must have to meet the uses to be made of it in actual service. The Ordnance Department frequently makes recommendations covering the establishment of required types. When made these are generally coördinated with the using and supply branches and submitted with the approval of the technical committee. The same War Department responsibility exists for important cases of new and improved articles to meet existing needs. In general, it is the intent of the War Department to establish clearly and approve the need for a new or improved article before extensive work is done by supply branches to develop an article to meet the new requirements or performance specifications are set up, but it is also clearly stated in Army Regulations 850-25 that the War Department does not desire to limit the development work of the supply branches exclusively to articles the military requirements of which have been formulated or approved. Preliminary work with a view to the formal establishment of a required type may be done by the supply branches. By far the greater part of our development work since the World War has been on required types established by the approved report of the Caliber Board, or Westervelt Board, which met in 1919 in France.

(2nd) The War Department having established the need for an article and having set up the general performance specifications which it must meet, it is a function of the supply branches, through research and development work if necessary, to procure an article to meet these performance specifications. If development work is necessary, which is usually the case in articles of ordnance, the successive steps are intensive study of the performance specifications, study of similar articles in our own and foreign services or, if a commercial article is applicable, a study of various commercial types. Then follows preparation of sketches by the Manufacturing Service, study and coördination of these with the using branches by the Technical Staff. It may be, and usually is the case, that the performance specifications may be satisfactorily met by many different designs, some of which will have advantages in some features and disadvantages in other features when compared with other satisfactory designs. In other words, there are generally several satisfactory solutions of the problem. In the case of two designs, both of which meet the requirements of the using service equally well, the choice may well be determined by the relative possibility of getting rapid production or by the cost.



An Ordnance Standard of Today
Giant 14-inch gun on railway mount, emplaced, in action at Fort MacArthur, Calif.

There is no question that possibility of rapid production and cost—the two are related—are important considerations together and separately and may at times justify the selection of an article not so efficient from the users' point of view. This is illustrated in the use during the World War of the simple and cheap trench mortar instead of a more complicated weapon which might have been more efficient.

Preliminary designs having been fully considered by a sub-committee of the Ordnance Committee, final approval is given through committee action for the manufacture or procurement of one or more pilots. If manufactured, they are given a shop functioning test at the place of manufacture and then if the article is a cannon or its mount, a small arm or an automotive vehicle, it is sent to the proving ground for a more extended test. As a result of these Ordnance tests weaknesses may develop in the design and certain parts may have to be redesigned, the new parts supplied and the test continued. It may also become evident during these tests that a modification of the performance specifications must be made to permit them to be met.

The main functions of the proving ground test are:

(1st) To determine that the parts of the article have sufficient strength and durability from an engineering point of view.

(2nd) That the article functions as intended and complies with the performance specifications.

If the article is one pertaining to Infantry or Field Artillery, it will have been under the observation of representatives of those branches while under test at the proving ground. The test at the proving ground is normally conducted according to a Technical Staff Test Program approved by the Ordnance Committee and by the appropriate sub-committee thereof, the latter consisting of representatives of the Technical Staff, the Manufacturing Service, and of the using and other interested branches. Sometimes, in order to save time, the proving ground test of pilot articles has been greatly curtailed and in certain cases entirely omitted. Even if it is possible to make a shop test of the article at the point of manufacture, it is very desirable to have the article handled and subjected to an engineering and performance test by others than those connected with the manufacture and design before it is sent to the using branch for service test. In this way it is thought that engineering defects can be more quickly detected and corrected.

If the results of the proving ground test are reasonably satisfactory, the next step is to send one or more of the pilot articles to a using branch for test. Instead of being an experimental type the article now becomes a service test type. This matter again is handled by a subcommittee of the Ordnance Technical Committee as to obtaining the necessary authority for the service test from the War Department, time of release, matériel to be furnished, etc., but the preparation of the program of test is left entirely to the using branch. The object of this service test is not primarily to develop mechanical weaknesses or malfunctioning in the article, as these are already supposed to have been brought out by the proving ground test, but rather to determine, as far as practicable, whether it will meet tactical requirements and whether it is convenient and adaptable for service use in various situations and terrains. Of recent years service tests have usually been made under the supervision of service boards.

The Ordnance Department, through the branch representatives on the Technical Committee, receives reports of progress of the tests by these Boards and visits are made by Ordnance representatives to observe the tests and to furnish information concerning the matériel.

Reports having been received from all Ordnance and service tests, the next step is to be decided upon. If all reports are favorable, the article is in line for standardization. If serious faults are developed, or if it appears that the performance specifications should be changed, there is nothing to do but to get out a new pilot and again run the gamut of tests. We had a case—the pack howitzers — where the performance specifications were raised by increasing the maximum range after two successive pilots had been gotten out. Fortunately, the first longer range pilot, with relatively minor changes, satisfied all conditions and was standardized.

IT IS readily seen that the development of even a single article of a complicated character such as a gun and its carriage would take considerable time, even if the time consumed in Ordnance and service tests were not considered. These tests add materially to the time required to place the article in line for standardization and if several models have to be gotten out before a satisfactory one is produced, the delay is greatly increased. There is no question that under existing regulations as to procedure, and with existing limitations as to expenditure of funds, it may take five years or more to produce and standardize a new article of as complicated a nature as a gun and its carriage. Excellence of engineering at the outset may reduce this time, but it will no doubt always be longer than if the engineer were given a free hand without regard to any coördinating agency, as he is in commercial concerns, in theory at least. The difference of course is that the commercial concern goes into competition with the world in the sale of the particular article which it produces and if the engineer has failed (in the case of a mechanical article) to produce one which can hold its own, its production does not get far and we do not hear much of it. On the other hand, if the article appeals to the public, it becomes a commercial success and the engineer deserves much of the credit for making it so. In the Army the using branches are the public in so far as the supply branches are concerned. Since the using and supply branches all belong to one organization, it is possible to find out what the latter want directly and not from an opinion on that question through statistics as the engineer of the concern producing a commercial article is forced to do. The procedure to do this, as outlined in Army Regulations 850-25, seems well adapted for the purpose.

A good idea of the volume of development work in progress is given by the number of items passed through the Ordnance Committee in the years from 1919 to 1927, inclusive. The number by years is as follows:

1919	440
1920	706
1921	714
1922	711
1923	893
1924	902
1925	744
1926	768
1927	801

Probably 60 per cent. of these items mark some definite step in the development of new or the modification of old matériel or with tests of such matériel. The other 40 per cent. relate to inventions, obsolescence, etc.

If it is decided to standardize the article, the first step is to clear it for procurement through the Office of the Assistant Secretary of War. Answers must be made to a specific set of questions. These are prepared by the Technical Staff in consultation with the Manufacturing Divisions concerned. When clearance has been obtained for procurement, formal recommendation is made to the Adjutant General that the article be standardized. Here again answers are prepared to a list of questions. If this recommendation is approved, the article becomes the standard.

The standardization of an article usually involves the transfer of some other article to the substitute or to the limited standard list.

To keep a record of unit assemblies of ordnance as to status with respect to standardization, there was prepared

in the Technical Staff a number of years ago a Book of Standards which contains lists of required types and standard, substitute standard and limited standard articles. Component parts of articles or accessories are not listed in this book unless they form important items of separate issue, as fuzes, panoramic sights, etc. The Book of Standards is revised about once a year, except that one up-to-date copy is always on hand in the Technical Staff.

The standardization of a mechanical article and the standardization of specifications under which it is to be procured are not simultaneous operations. In practice the article is always developed first, from approximate performance specifications. Standard procurement specifications may not be worked out until much later. In this respect our present practice and commercial practice agree.

Standardization of specifications forms, however, an important part of the general standardization movement as it is only through this method that wide-spread standardization extending to all industries and to all parts of the country can be effected. Steady progress is being made in the standardization of specifications of raw material, particularly steels and metals, as well as in the specifications for semi-finished and finished ordnance matériel. In this work our bases for commercial material are the specifications issued by the Federal Specifications Board, on which are representatives of the American Engineering Standards Committee and of other engineering societies.

In the preparation of specifications for non-commercial ordnance matériel, we coöperate with the various engineering societies through representation on sub-committees.

WHILE the subject of this paper is progress in standardion, there has been given in some detail a description of the machinery established for standardization. This was done because the actual statement of the progress since the war will not be long, and the progress made is dependent upon the methods set up, since anything short of virtual compliance with these methods will not result in coördination with the interested branches and hence will not result in real standardization.

It must be pointed out that the number of articles standardized does not give a good idea of the development work involved, since the work on discarded pilots was almost as great as on those that were finally accepted, and in nearly every case we tried in parallel or in series several pilots or at least we investigated more than one design. In the 75-mm. gun we built and tested 7 guns and 5 mounts differing from each other enough to rate them as separate pilots. In the development of the 105-mm. howitzer, we tried a similar number of guns and mounts. In smaller matériel, including ammunition, fuzes, etc., the number of articles tried in the development has been generally larger.

There are at present other articles in the process of development, some types of which will finally reach standardization. Among the important ones may be mentioned improved 155-mm. howitzer matériel, 155-mm. gun and 8-inch howitzer matériel. Still other pilots were developed and abandoned on account of lack of or changes in requirements. In this class were the early infantry howitzers and pack howitzers, the army tractors, and self-propelled mounts. Possibly the 4.7-inch gun may also be placed in this class but final decision has not been made. Although there are still some weak points, namely, the imperfect development of a part of the field artillery matériel including its ammunition, lack of standardization of any part of the corps and army matériel, it is considered that the progress made in nine years has been very satisfactory when all the difficulties of the problems presented are considered.

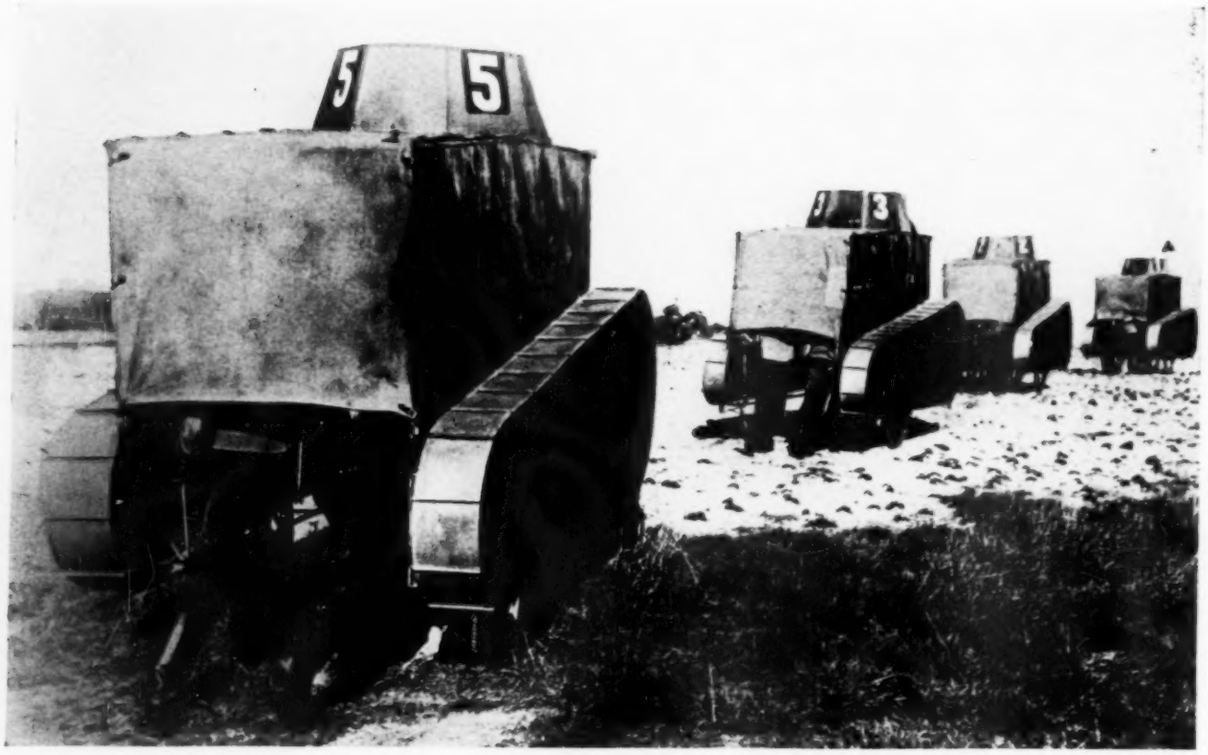
It is of interest to compare progress made in the standardization of new articles in the nine years, 1919-1927, inclusive, with progress made in 1899-1907, inclusive. The earlier period was also one of intensive development of Ordnance in this country. Some of the principal articles developed during this period are:

Springfield Rifle, Model 1903; 3-inch Field Gun, Model 1902; 3.8-inch Field Gun; 4.7-inch Field Gun; 3.8-inch Field Howitzer; 4.7-inch Field Howitzer; 3-inch 15-pdr. Gun, Barbette Mount; 14-inch Gun, Disappearing Carriage.

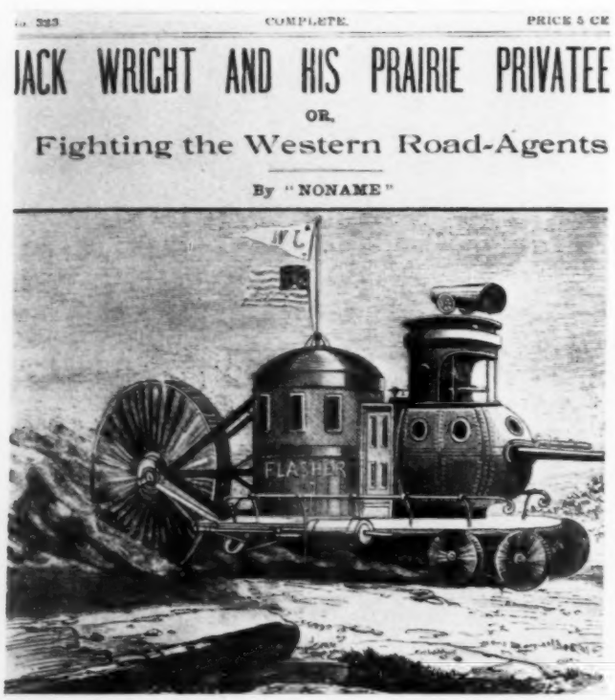
Ammunition for the various weapons was also developed. It is to be noted that only three of these items, namely, the Springfield Rifle, the 3-inch Field Gun and the 4.7-inch Gun were adopted for the Army during this period. The others except the 3.8-inch Field Gun were later adopted. Excellent matériel was developed in this period, particularly in the caliber .30 rifle, model of 1903, and the 3-inch field gun, model of 1902. There was not, however, in those days the official coördination during the progress of development and test which is provided for in Army Regulations 850-25 and in the organization of the Ordnance Department. Such coördination as was effected was through personal contact between the Ordnance people engaged in the design and representatives of the using branches who were interested in and had had experience with the subject or article under consideration. Neither the Ordnance Department nor the using service representative spoke officially for his own branch, though both generally had strong opinions on the subject under consideration. In a large organization like the Army or any branch of it there is, of course, a necessity for arriving at decisions in the course of the development of an article which officially are those of the branches and since one person, as the chief, cannot always do this, it is necessary that machinery be set up for arriving at such official opinion. The machinery for standardization has been described. The opinions thus arrived at may not always be infallible, but they are at least the result of an honest effort to arrive at the best thought of the branches concerned on the matter in question.

It is believed that the matériel now being developed more certainly and more nearly meets the requirements set up than that developed in the earlier period. This may partly be accounted for by the fact that the requirements have been more definitely determined and more clearly stated. But, beyond that, I think that, on the average, pilot types are better worked out than formerly. Further, it seems evident that with the present system of coördination with the using branches the designs when finally completed should be as satisfactory to those branches as it is possible to make them.

Dummy, Imaginary and Real Tanks



Dummy Tanks—made of canvas and mounted on bicycle wheels—used in recent maneuvers at Berlin in honor of the King of Afghanistan. Under the peace treaties the building of tanks by Germany is prohibited.



The Forerunner of the Tank—the imaginary vehicle of "No Name" whose heroes in Western stories thrilled readers of the early 90's.

Wireless equipment is among the latest accessories on English Whippet Tanks. The operator is shown receiving orders via the air.

A Recent Advance In The Exterior Ballistics of Shot Guns

By Philip P. Quayle*

THE general question of the importance of shot string is one which has been argued pro and con for a long time. This is especially true of late years when a considerable mass of advertising literature has appeared on this subject clouding the real issues and distracting the readers attention with entirely irrelevant details. As a result of all these conflicting arguments it is a most difficult matter for the average shooter to determine what portion, if any, of these statements is based upon sound experimental investigation and what portion is mere unsupported personal opinion.

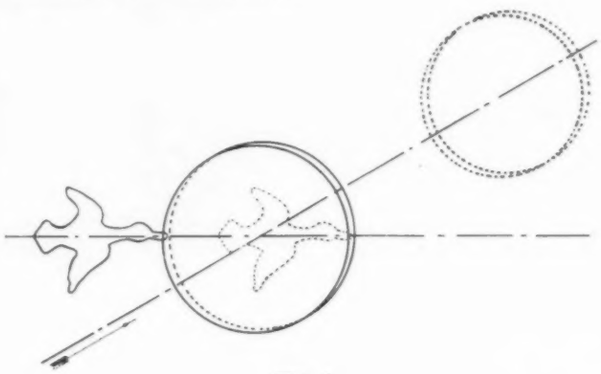


Fig. 1

This illustration shows an utterly fictitious load having a shot string 30 inches in diameter and one inch in length. This length of string has been chosen because it is the most favorable case for those advocating the shortest possible shot string. The full line portion shows a goose flying across the trajectory at right angles at a speed of 60 miles an hour or 88 feet per second. Its beak is just touching the outer rim of the shot column.

Flying at a speed of 88 feet per second it will require 0.0284 seconds for the goose to cross the 30-inch diameter of the shot string at the end of which time the shot column will be approximately 22.8 feet further down the range and clearly such a shot will always be a clean miss.

We have no wish to abrogate the inherent right of the individual to form his own opinion in regard to the importance of shot strings. However, if one is of open mind and wishes to know the truth in regard to any particular phenomenon he must be willing to subject these opinions to the acid test of experiment and let them stand or fall by the result.

We have previously shown** that shot strings of reasonable length, say fifteen feet, and an average velocity of even 800 feet per second are in no way detrimental and are in fact highly desirable for targets moving across the trajectory at considerable speed. We shall give a brief resumé of the arguments as set forth in the paper referred to.

If a target is moving directly towards or directly away from the shooter then the only effect will be that in the first case the effective velocity of the charge will be augmented by that of the target and in the second case it will be diminished by the same amount. In this case it is evident that the length of the shot string is of no importance whatever as long as the rear-most pellets of the shot string do not fall below the killing velocity, which certainly would not occur with any good standard shell now on the market.

The most difficult shot, other factors remaining equal, will usually be that in which the target crosses the trajectory at right angles and at the highest speed. In such a case the shooter must determine how far to "lead" the target and a moment's consideration will suffice to show the slight probability of success if concentrated shot strings were really available. To consider an extreme case, suppose that the shot charge after leaving the muzzle did not spread out along the trajectory but traveled towards the target as a disc one inch in thickness say, and thirty inches in diameter. It is evident that only the closest sort of shooting would enable one to hit the target.

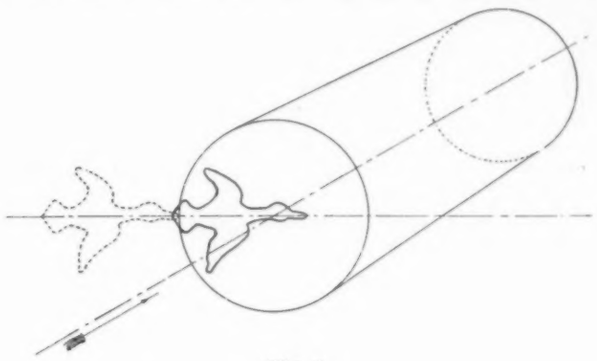


Fig. 2

This figure shows a shot string 15 feet long at the 40-yard range. The beak of the goose is just barely outside the 30-inch circle it is about to enter as indicated by the dotted outline. It has been shown in a previous article that when the end of the 15-foot shot column passes the goose it will have passed into the shot column a distance of 22 inches or more, two-thirds of its diameter. Evidently such a load will be far more efficacious than the one of Figure 1, and it enjoys one further advantage in that shot strings of this length are common and those of one-inch in length never occur.

However, it was clearly demonstrated in the paper previously mentioned that in the case of such a difficult shot as that being considered a shot string length of fifteen feet and an average velocity of the pellets of 800 feet per second would greatly increase the chances of success. A goose flying at 60 miles per hour or 88 feet per second will move across more than two-thirds of a shot string 30 inches in diameter while a 15-foot shot string moving at 800 feet per second is passing it. It will thus be struck by a large percentage of the shot pellets which, had the shot string really been extremely short would obviously have missed.

It will be shown later on in this paper that the standard shells of all manufacturers are the same in so far

*Chief Physicist, Peters Cartridge Company, Cincinnati, Ohio.

**American Rifleman, May and June, 1928.

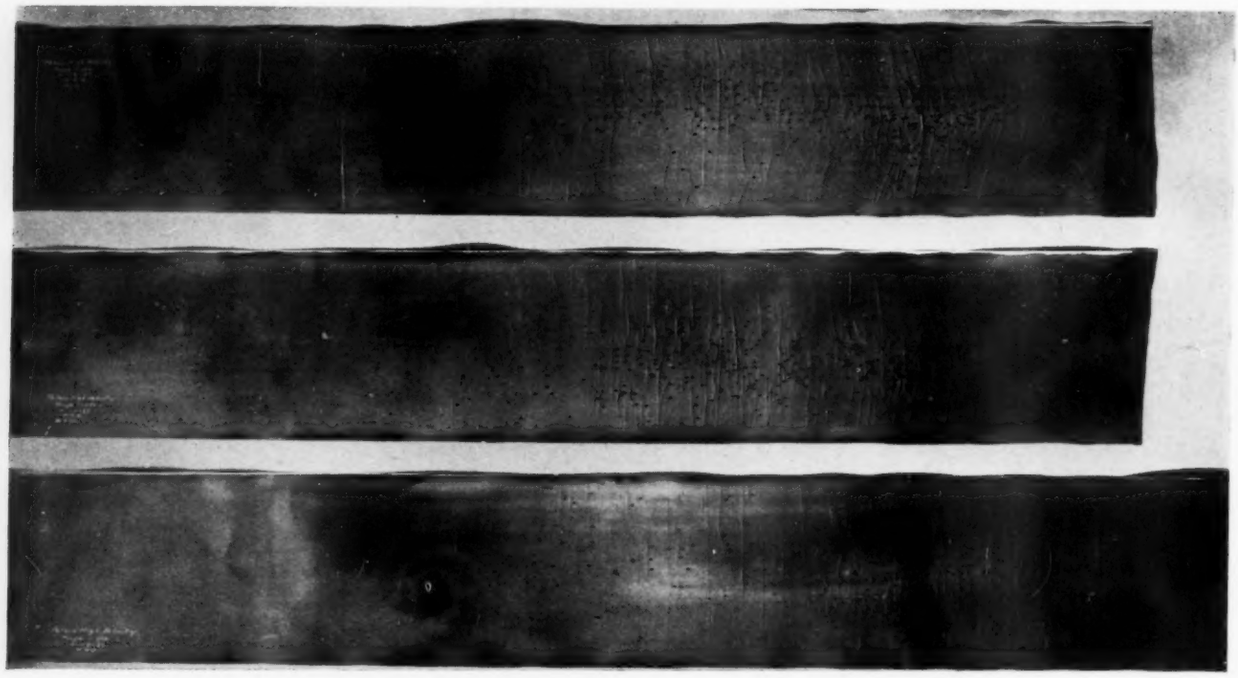


Fig. 3
These spark photographs taken at a range of 11 yards from the muzzle, show the distribution of the shot from Peters High Velocity shell.

as length of shot string alone is considered. Such shells have shot strings at 40 yards of from 10 to 14 feet in length and it is fortunate that this is so in view of the difficulties previously enumerated. The foregoing remarks are illustrated graphically in Figs. 1 and 2.

Thus we see that the origin of and the necessity for a short shot string is, like the famous Dodo of the Smiling Island, a shrouded, inscrutable mystery.

THE problem of determining the length of a charge of shot at a range of 40 yards from the gun is a difficult one. It has received the attention of various experimenters from time to time.

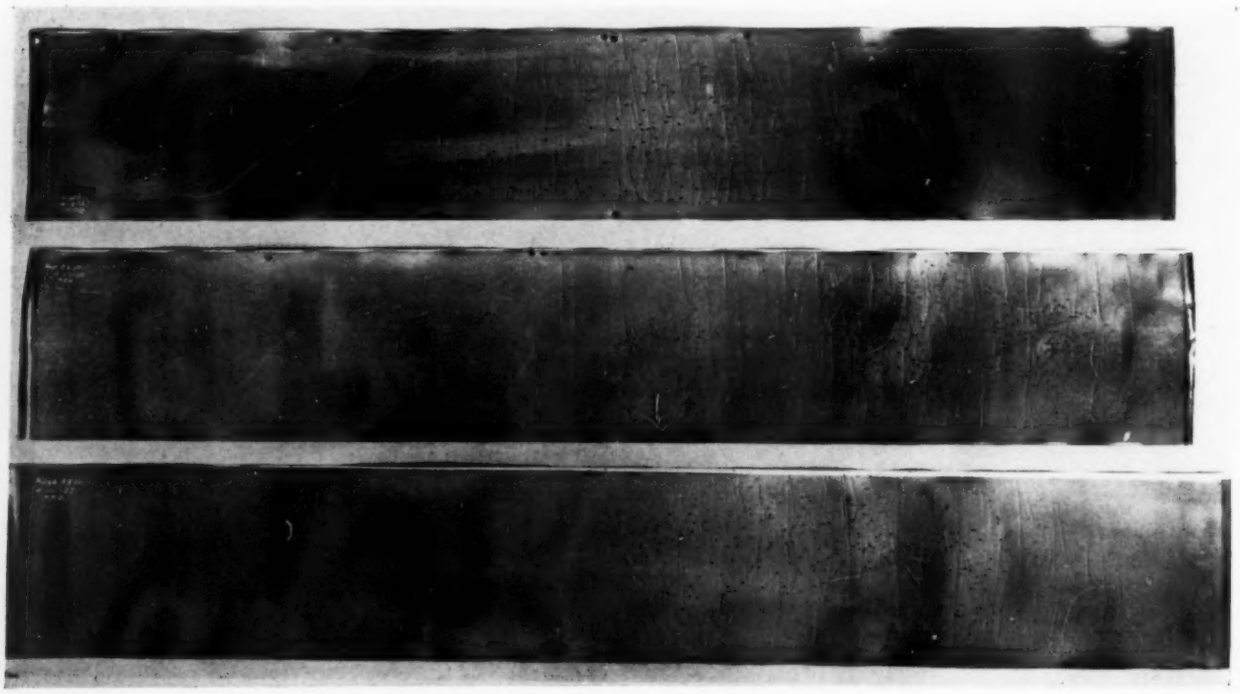


Fig. 4
These spark photographs, taken at a range of 11 yards from the muzzle, show the distribution of the shot from shells of Competitor "A."

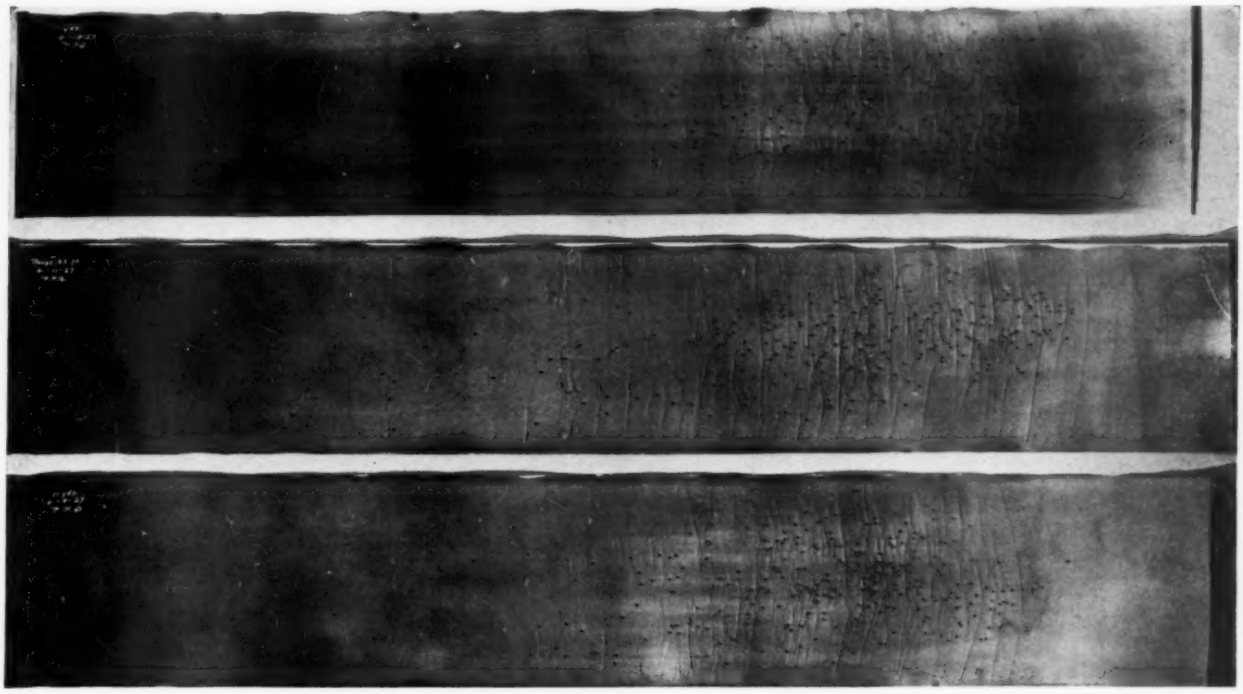


Fig. 5
These spark photographs, taken at a range of 11 yards from the muzzle, show the distribution of the shot from shells of Competitor "B."

Some of these attempts have been quite inconclusive and some of the methods were quite incapable of detecting the phnomenon in question.

The spark photographs of shot strings at short range published in the *American Rifleman* in 1925 constituted, as far as we are aware, the first actual full-sized photographs of such phenomena.

However, the Physical Laboratory of the Peters Cartridge Company has succeeded in taking actual full-sized photographs of the shot strings of shells of various manufacturers at ranges up to and including 40 yards from the muzzle of the gun. This is the first time that an entire shot string at 40 yards has ever been photographed, nothing even remotely approaching it, having ever before been attempted. As a result of these photographs, we are able to say, for the first time in the history of ballistics, what the actual distribution of the shot pellets really is.

The apparatus with which these photographs are taken is the most complete and precise electric photographic equipment ever constructed. These photographs are secured without touching or interfering with the shot in any manner whatsoever. Even the actual operation of the apparatus is automatic and is set off by the sound wave which accompanies the discharge of the gun. It is therefore unnecessary for the shot pellets to pierce sheets of

TABLE 1

Shot String Tests at 11 Yards from Muzzle

MANUFACTURER	Nominal Shot Charge	Trial	Length of Shot String in Feet as Measured on a Film 10 Inches Wide and 5 Feet Long, Including		
			100% of the Shot Pellets	75% of the Shot Pellets	50% of the Shot Pellets
Peters—High Velocity	1¼ oz. No. 7 ch	1	4.7	1.5	1.0
		2	3.9	1.5	1.0
		3	4.2	1.4	0.8
		Ave.	4.3	1.5	0.9
Competitor "A"	1¼ oz. No. 7 ch	1	4.4	1.2	0.8
		2	4.5	1.7	1.2
		3	4.1	1.5	1.1
		Ave.	4.3	1.5	1.0
Competitor "B"	1¼ oz. No. 6 ch	1	4.0	1.5	1.0
		2	4.1	1.8	1.3
		3	4.0	1.4	0.9
		Ave.	4.0	1.6	1.1

TABLE 2

Shot String Tests at 40 Yards

MANUFACTURER	Nominal Shot Charge	Trial	Length of Shot String in Feet as Measured on a Film 31.5 Inches Wide and 20 Feet long, Including		
			100% of the Shot Pellets	75% of the Shot Pellets	50% of the Shot Pellets
Peters—High Velocity	1¼ oz. No. 6 ch	1	9.7	5.5	2.6
		2	12.6	4.1	3.2
		Ave.	11.2	4.8	2.9
Competitor "A"	1¼ oz. No. 6 ch	1	13.2	6.0	4.9
		2	10.9	5.1	3.4
		Ave.	12.0	5.6	4.2
Competitor "B"	1¼ oz. No. 6 ch	1	13.8	5.2	4.1

paper or other material thus incurring uncertain decelerations and disturbances.

It is evident that a spark photograph of a shot string portrays the actual distribution of every shot pellet in the charge. It accomplishes this directly and without complication, presenting for leisurely study the record of the shot pellets as it existed in the one or two-millionths of a second required to take the photograph.

Hence, regardless of what we may hope or wish to believe in regard to any particular load, we must, if we are of open mind, compare our beliefs with authentic records of the phenomena whenever available and modify our views accordingly.

SINCE spark photography is the only method available at present by which we may obtain absolutely unbiased records of shot strings, it constitutes, as it were, the verdict of the supreme court, from whose decision there is no appeal.

With this in mind we have obtained the same type of load of each of three different manufacturers and fired these loads from the same gun under the same conditions of temperature and humidity. We have obtained photographs of these three different makes of shells and compared the results. Our conclusions in regard to these various loads at 11 yards may be checked by anyone so inclined since the photographs at this range are of such a size as to make feasible reproduction in this paper.

Shells of Competitor "B" loaded with No. 7 chilled shot were not available at the time of our experiments. However, at a range of 11 yards the shot string measurements here presented would suffer no appreciable change had No. 7 shot been used instead of No. 6.

At the range of 11 yards at which the above spark photographs were taken (Figs. 3, 4 and 5) the shot charge of any of these shells is sufficiently spread out so that it seems highly improbable that collisions or disturbances resulting from the top shot wad would any longer occur.

The films of the entire shot string from which the above data were obtained were each preceeded by some twenty test films showing the same distribution of the shot pellets of the head of the column.

Other factors being equal, the smaller the size of the shot the longer the string but this in itself is misleading. In measuring the total length of the shot string, it frequently happens that the last few feet of the film will contain only a very small portion of the shot, sometimes only three or four pellets. Thus several feet may be added to the length of the string by the pellets of least importance because of their low velocity. It is a better measure of shot string length to consider only the length including, say 75 per cent. of the shot pellets since this measures in reality the length of the most effective part of the load.

However, it is interesting to note the manner in which the shot distributes itself and with this in mind the accompanying Tables 1 and 2 have been prepared. These data show that at a range of 40 yards the average shot string for No. 6 chilled shot is 12.0 feet long. This length may be further divided approximately as follows: the first 3.6 feet contains 50 per cent. of the shot pellets, the next 1.6 feet contains 25 per cent. and it is in this region that the shot pellets are most dense, finally the last 6.8 feet of the shot string contains the remaining 25 per cent. or least effective portion of the shot pellets.

There is no shot shell in existence in which the shot pellets are concentrated at the head of the column nor would this be any particular advantage if it were true, and as already shown in a previous paper it might be a considerable disadvantage.

It will probably be evident to the most casual reader that from the standpoint of *length of shot string alone* there is absolutely nothing to commend one of these shells in preference to another.

In conclusion, we believe that the spark photographs here presented supply incontrovertible evidence to prove that insofar as the length of the shot string alone is concerned the shells of the three manufacturers mentioned in this article are absolutely identical within the limits of the slightest practical importance. Since these shells are typical of the best grades of shot shells the world over, our remarks here are equally applicable to them all.

This issue of Army Ordnance *concludes Volume VIII, an index to which is published herein. The index, with title page for binding, is arranged alphabetically by subject and author. Bound copies of this journal comprise a current and authentic record of American munitions developments and activities.*

Curved versus Cartesian Coordinates in Ballistics

By Maj. Roger Sherman Hoar,* Ord. Res. U. S. A.

THE computations employed in modern ballistics are quite properly carried on in a rectangular Cartesian coördinate system. But, when it comes to applying the results of these computations to the actual spheroidal earth, two alternative conventions have been employed. The object of this paper is to discuss and compare these two conventions.

First, however, for the sake of completeness, let us set down briefly some of the fundamentals of "modern ballistics," by which phrase is meant the system introduced by Maj. F. R. Moulton during the World War. The entire development of the science of ballistics, from Newton and Euler down to Siacci and Ingalls, proved inadequate for the high-angle long-range gun-fire of modern warfare, and so had to be superseded by the Moulton method and its foreign counterparts, which went back to first principles, and evolved a science wholly new and independent of what had gone before. The basic equations of motion of modern ballistics are:

$$\begin{aligned} x'' &= -Ex' \\ y'' &= -Ey' - g \end{aligned} \qquad (1)$$

in which, according to the Lagrange notation:

$$\begin{aligned} x' &= \frac{dx}{dt} \\ y' &= \frac{dy}{dt} \\ x'' &= \frac{dx'}{dt} = \frac{d^2x}{dt^2} \\ y'' &= \frac{dy'}{dt} = \frac{d^2y}{dt^2} \end{aligned} \qquad (2)$$

In these definitions, x and y are the coördinates of the center of gravity of the projectile, and t represents the time. Thus x′ and y′ are seen to be the components of velocity, and x″ and y″ the components of acceleration.

E is defined as follows:

$$E = \frac{GH}{C}$$

in which G is a tabular empirical function of velocity (v), such that vG represents the retardation experienced by a (purely hypothetical) "standard projectile," traveling at sea-level, with velocity v, through standard still air.

H is defined as follows:

$$H = e^{-hy}$$

in which e is the base of the system of natural logarithms, and h is 0.0001036. H represents the theoretical ratio of retardation at y meters above sea-level, to the retardation at sea-level, all in standard still air.

C is defined as follows:

$$C = \frac{w}{id^2}$$

in which w is the weight of the projectile in pounds; d its diameter in inches, and i the "coefficient of ignorance," which embraces the effect of the shape of the projectile and a number of unknown considerations. C represents the ratio of pressure exertible, against the air, by the projectile in question, to the pressure exertible by a "standard projectile," all other conditions being equal.

So that Ev represents the retardation, due to the resistance of the air against the projectile in question, at altitude y.

The acceleration of gravity is represented by g, and is considered to be 9.80 meters per second per second, regardless of altitude or latitude.

Equations 1 treat the projectile as a particle, thus eliminating the effects of yaw and drift. Furthermore they assume a rectangular Cartesian coördinate system, with a constant gravity acting along the y-lines. This amounts to assuming that the earth is a flat slab, extending without limit in all directions, as will be seen from the following considerations.

If the earth were a homogeneous slab of thickness Q, of density p, and of infinite extent; and if a unit point-mass, a distance D from a cube of earth of unit dimensions (the mass of which is regarded as concentrated at its center), were assumed as attracted to the cube with a force equal to $4.9/\pi\ QD^2\ p$, then it can easily be shown, by two simple integrations, that any object anywhere in space above the surface of this hypothetical earth would be attracted vertically downward with an acceleration of 9.80 meters per second per second, regardless of altitude above the surface.

For such an earth, the equations of motion of a projectile in flight are as given in equations 1.

But the actual earth—Prophet Voliva of Zion City to the contrary notwithstanding—is *not* flat. Thus the question arises: how can we apply Cartesian coördinates to our actual earth?

Under the old Siacci-Ingalls ballistics, this question was answered by setting the x-axis tangent to the earth at the gun, as in Fig. 1. This same convention was at first em-

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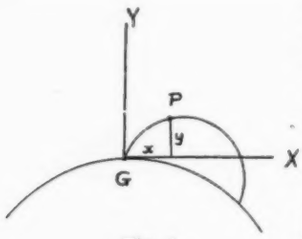


Fig. 1.

ployed in the Moulton ballistics; but it was a legacy of the old ballistics, and like the old ballistics was finally discarded. It will, for convenience, be referred to herein as the *old* system.

IN 1920, as the result of a three-cornered correspondence between the Technical Staff, the Ballistic Section of Aberdeen Proving Ground, and the Ordnance School of Application, a new coördinate system was officially adopted. This new system is shown in Fig. 2. It will, for convenience, be referred to herein as the *modern* system. There is, strictly speaking, no x-axis in the modern coördinate system. We measure x along a level surface from the gun (G) to a point directly under the projectile (P), and then measure y from this point vertically up to the projectile; thus the y-lines are seen to be perpendicular to the earth's curvature.

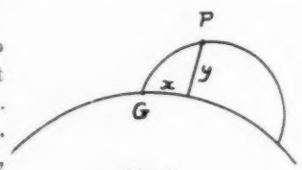


Fig. 2.

Let us compare these two systems from the viewpoint of convenience and precision.

Convenience of old system. In the old coördinate system, a portion of the trajectory lay beyond the "point of fall," i. e., the point where y equals zero. This much of the trajectory had to be taken out from the observed range-firings, to get the data for range-table computations. When these computations had been completed, the curvature correction had to be added in again. Both the taking out and the reinserting of this curvature correction were often omitted, on the ground that they were negligible. This omission amounted to the inadvertent use of the modern coördinate system, without the computer realizing that this was so.

Furthermore no bit of data that one got anywhere on the trajectory related to the earth, but rather all related to the purely fictitious x-axis, and had to be corrected to relate them to the earth.

Precision of old system. The old system introduced three errors into the computations. First, there was an x-component of gravity, which was not accounted for in equations 1. Secondly, the y used as the basis for the H-function was not the actual altitude. And thirdly, no account was taken of the change in gravity with altitude and latitude. Whenever the computer was inadvertently using the modern system of coördinates, as mentioned above, this of course eliminated the first two of these errors, although thereby substituting the errors referred to under the new coördinate system, infra. The third error, which is common to both systems, is easily obviated by gradually altering the value of g from the proper initial value as the computation proceeds, and this was sometimes done.

Convenience of modern system. The modern system is very convenient. The observed range is used as the basis for ballistic computations. All computed results relate directly to the earth. There is no such thing in modern ballistics as a correction for curvature of the earth, and thus there is one less correction to bother the battery commander. In the case of such short-range guns as are aimed by sighting, although theoretically the old tangent-plane coördinates ought to be used with the straight gun-target line as the base of the trajectory, yet practically the difference between the two systems at *such* ranges is negligible.

Precision of the modern system. The modern system is substantially an infinitesimally distorted Cartesian grid, with its x-axis bent to conform to the surface of the earth, and its y-lines thereby caused to diverge slightly. This distortion introduces about the same degree of error in the computations, as do the first two errors listed under the old system. The dependence of gravity on altitude and latitude is the same in both systems.

The modern system is thus seen to be so much more convenient than the old, not only to the ballistician but also to the battery commander, that it would be used even if it were slightly less precise. But, as it is equally precise, there is not much field of usefulness left for the old system, except in long-range firing in the Navy, where direct sighting makes a flat datum desirable.

As a matter of fact, as the few present-day ballisticians who were in the game as far back as 1920 will remember, it was neither convenience nor precision which caused the adoption of the present convention in 1920. The reason which compelled us to make the change was the practical impossibility of keeping track of the curvature correction under the old tangent-plane convention. Sometimes the range-firing officer would reduce the observed curved range back to the tangent range, and then the computers would assume that he hadn't done so, and they would do it again. Or when he hadn't done so, they would assume that he had, and so they would omit to do it. In one actual case, we found that the curvature effect had been taken out of the same range *three* successive times, and even then the results published as being the *curved* range! This was the last straw, which started the investigation which eventually led to the official abolition of the curvature correction.

Let us compare the complete equations of motions of each system, with the equations used in computing in both.

In all computations in *both* systems, the flat slab earth is assumed, and we have:

$$\begin{aligned} x'' &= -Ex' \\ y'' &= -Ey' - 9.80 \\ v^2 &= x'^2 + y'^2 \\ \tan\vartheta &= \frac{y'}{x'} \\ \log_e H &= -hy \end{aligned} \qquad (3)$$

ϑ is the angle between the horizontal and the tangent to the trajectory. It may be called the inclination of the trajectory at the point under consideration.

In the old coördinate system, although equations 3 were the ones *used* in computation work, the *precise* equations, assuming a spherical earth, were:

$$x'' = -Ex' - g\frac{x}{\sqrt{(R+y)^2 + x^2}}$$

$$y'' = -Ey' - g\frac{R+y}{\sqrt{(R+y)^2+x^2}}$$

$$v^2 = x'^2 + y'^2 \qquad (4)$$

$$\tan\vartheta = \frac{y'(R+y)+xx'}{x'(R+y)-xy'}$$

$$\log_e H = -h\left[\sqrt{(R+y)^2+x^2}-R\right]$$

R is the radius of curvature of the curve in which the plane of fire cuts the surface of the earth, and may be taken as roughly 6,000,000 meters.

In modern ballistics, although equations 3 are the ones *used* in computation work, the *precise* equations, assuming a spheroidal earth, are:

$$x'' = -Ex' - \frac{2x'y'}{R+y}$$

$$y'' = -Ey' - g + x'^2\frac{R+y}{R^2}$$

$$v^2 = x'^2\frac{(R+y)^2}{R^2} + y'^2 \qquad (5)$$

$$\tan\vartheta = \frac{y'}{x'}\,\frac{R}{R+y}$$

$$\log_e H = -hy$$

In both systems the value of g, instead of being 9.80, as assumed in computing, is sensibly:

$$g = 9.806 - 0.026\cos 2l - \frac{y}{300{,}000} \qquad (6)$$

This is the Helmert formula, as published in the *Nautical Almanac*, but with the last term put into more convenient form for computers. l is the latitude. As cos 2 l varies from unity at the equator to minus unity at the poles, g at sea-level will vary from 9.780 to 9.832, with a mean value of 9.806 at latitude 45°. An altitude of ten kilometers would reduce g from 9.806 to 9.773.

Equations 5 are due to 1st Lieut. W. E. Roth, F. A., Wis. N. G. (see his article, referred to later herein), but were earlier derived in expanded form by the present author.

IN ALL the foregoing, we have assumed that the curve in which the plane of fire cuts the earth is a circle. But the earth is really a spheroid, and the plane of fire cuts it in a curve indistinguishable from an ellipse. Thus in the old coördinate system we must correct for curvature, back and forth between an ellipse and its tangent; and in the modern coördinate system, our x-line is an ellipse and our y-lines are the normals to that ellipse. Accordingly it might seem that this fact would introduce appreciable additional terms into equations 4 and 5. The author is indebted to a recent suggestion from Aberdeen Proving Ground that no treatment of the subject can be considered complete unless this question of ellipticity be disposed of.

However, a lengthy discussion of that problem here would distract from the main object of this paper. Accordingly let it merely be stated that, following the suggestion from Aberdeen, the matter has been thoroughly investigated by the Marquette University Ballistics Research Group, with the following results. The greatest departure of the base of a trajectory from a true circular arc would occur when firing north or south at latitude 45°6′. Assuming, under these conditions, a one-hundred kilometer range (62.137 miles), which is a longer range than we are likely to encounter in many years, at which range the earth drops away from the tangent plane datum of the old coördinate system a distance of 785 meters, it was found that the assumed circular base of the trajectory would depart from the actual elliptical base of the trajectory by not over three-quarters of a centimeter at any point in that entire range, and that the assumed y-lines would diverge from the actual vertical lines by an angle never more than four one-hundred-thousandths of a second. If that is the maximum distortion to be encountered, in an impossibly long range, when firing in the direction and at the latitude of the greatest eccentricity of the earth's surface, it is quite clear that we can entirely disregard the ellipticity of the earth, and treat the base of the trajectory as a circular arc.

One further consideration, however, remains to be disposed of. Our R, although thus seen to be a constant for any given trajectory, has a slightly different value for each trajectory, depending on direction of fire and location on the earth's surface. Its extreme values are 6,399,700 meters at the pole, and 6,335,000 meters at the equator. At 45° latitude, the extremes are 6,367,400 and 6,388,700, according to the azimuth of fire. Thus, if we take for R a mean value of 6,365,000, the worst that this can do is to alter the already-almost-negligible second-order terms of equations 5 by one two-hundredth of their value. This is purely a *third*-order effect. In fact, in the expansions of equations 4 and 5, we can use 6,000,000 flat for R, with no very appreciable difference in results.

Accordingly the derivation of equations 5 on a circular basis is seen to be wholly justified.

Let us now return, for a moment, to the other coördinate system. Equations 4 of the old system, expanded and with third order terms dropped, become:

$$x'' = -Ex' - \frac{x}{600{,}000}$$

$$y'' = -Ey' - 9.806 + 0.026\cos 2l + \frac{y}{300{,}000}$$

$$v^2 = x'^2 + y'^2 \qquad (7)$$

$$\tan\vartheta = \frac{y'}{x'} + \frac{x\,y'^2}{6{,}000{,}000\,x'^2} + \frac{x}{6{,}000{,}000}$$

$$\log_e H = -h\left(y + \frac{x^2}{12{,}000{,}000}\right)$$

Equation 5 of the modern system, expanded and with third order terms dropped, become:

$$x'' = -Ex' - \frac{x'y'}{3{,}000{,}000}$$

$$y'' = -Ey' - 9.806 + 0.026\cos 2l + \frac{y}{300{,}000} + \frac{x'^2}{6{,}000{,}000}$$

$$v^2 = x'^2\left(1 + \frac{y}{3{,}000{,}000}\right) + y'^2 \qquad (8)$$

$$\tan\vartheta = \frac{y'}{x'}\left(1 - \frac{y}{6{,}000{,}000}\right)$$

$$\log_e H = -hy$$

The differences between equations 3 and equations 7 and 8 respectively are so slight numerically, that they can be absolutely disregarded at short ranges. Furthermore it can readily be seen that the terms $-x'y'/3{,}000{,}000$ (being negative when most effective) and $+y/3{,}000{,}000$ will tend to make the precise range, computed by equations 8, *less* than the approximate range, computed by equations 3; whereas the terms $+y/300{,}000$ and $+x'^2/6{,}000{,}000$ will tend to make the precise range *more* than the approximate, the net result being that these terms very nearly offset each other, and thus tend to make the results of using either equations 3 or equations 8 practically identical. This was verified by extensive computations of specimen trajectories, conducted by the Technical Staff, Ordnance Department, in 1920. For very long ranges the extra terms in either system can be made the basis for a differential correction at the close of the computations, or better still can be assimilated into a slightly altered value of the ballistic coefficient, C.

These differential corrections, in the case of the old coördinate system, are based on the following infinitesimal increments:

$$\delta x'' = +Ex'\frac{hx^2}{2R} - \frac{9.8x}{R}$$

$$\delta y'' = +Ey'\frac{hx^2}{2R} - 0.006 + 0.026\cos 2l + \frac{19.6y}{R} \qquad (9)$$

In the case of the modern coördinate system, the increments are:

$$\delta x'' = -\frac{Ex'^3 y}{R}\cdot\frac{d\log G}{v\,dv} - \frac{2x'y'}{R}$$

$$\delta y'' = -\frac{Ex'^2 y' y}{R}\cdot\frac{d\log G}{v\,dv} - 0.006 + 0.026\cos 2l + \frac{19.6y}{R} + \frac{x'^2}{R} \qquad (10)$$

The meaning of equations 9 and 10 will be made clear by the following example. Consider the $\delta x''$ of the first equation of equation 10. It means that, when we use the modern coördinate system (but compute with equations 3, using them as a convenient substitute for the precise equations 5), then at each point on the trajectory, the precise value of x'' will differ from the computed value of x'' by an amount equal to $\delta x''$.

The derivation of this $\delta x''$ will now be outlined for an example. Subtracting the expression for x'' in equations 3 from that in equations 5 gives us the term $-2x'y'/(R+y)$, which expanded and with third-order terms dropped becomes $-2x'y'/R$. Although the term $-Ex'$ *looks* the same in both equations, yet in *computing* this term, a slightly different v would be used when computing with equations 5 than when computing with equations 3, as will be seen by comparing the two sets of equations; and this difference, in the expression for v, results in the first term of the first equation of equations 10. As v does not enter into trajectory computations except through the G in E, and as ϑ does not enter into trajectory computations at all, we have thus accounted for all the differences between computing x'' by equations 3 and computing x'' by equations 5.*

In equations 9 and 10, I have left the constants h and R unconverted, the better to indicate the derivation of these equations; but have converted R in equations 6, 7 and 8 to its approximate numerical value, the better to indicate the small relative value of the second-order terms.

By inserting the values of $\delta x''$ and $\delta y''$ in the following formula, we get the total increment of actual range over computed range, in either case:

$$\delta X = \int_0^T v\,\delta x''\,dt + \int_0^T \varrho\,\delta y''\,dt \qquad (11)$$

v and ϱ being certain auxiliary variables, which are computed for every trajectory, for just this sort of use.

LIEUTENANT ROTH has devised a method of using the precise equations of motion of modern ballistics (equations 5) in the original trajectory computation, which method is probably simpler than to use equations 3, and then apply the differential correction. The Roth method was published in the *Field Artillery Journal* for September-October, 1927. Of course, in either coördinate system, it would be possible to use the conventional Moulton method of numerical integration, in addition merely computing the extra terms as one went along; but the Roth method is believed to be simpler even than this.

No method, analogous to Roth's, for using the precise equations of motion of the old coördinate system has yet been devised, so far as known to the author.

*Note. It has been suggested by Major A. W. Ford, O. D., that, as $\delta(Ex') = x'\,\delta E + E\,\delta x'$, then the term $-Ex'y/R$, the equivalent of $-E\,\delta x'$, should appear in the first of equations 10. This term is based on the assumption that the change in the expression for v, in passing from equation 3 to equation 5, effects a change in x'; this assumption in turn being based on the relation $x' = v\cos\vartheta$, "which," as Major Ford says, "should make it evident that v is used in the computation of $x'' = -Ex'$, and accordingly affects x'." This relation is obvious and elementary. But it should be equally obvious, to anyone who has computed trajectories by the Moulton method, that this relationship is **not** "used in the computation" even implicitly, for x' is **computed** by numerical integration of x''. As equations 10 are based on a comparison of two methods of **computation,** it would seem to the author that a physical relationship **not used in either computation,** either explicitly or even implicitly, cannot possibly **affect the computation.** Furthermore, x' equals $v\cos\vartheta$ only in one (No. 3) of the sets of equations which we are comparing, and not at all in the other (No. 5). Hence the term $E\,\delta x'$ is equal to zero, and does not enter into equations 10.

However, for practical purposes, the present G-function tables are so far from representing the actual law of air-resistance, that the use of these tables introduces errors which make the precision of equations 4 and 5 quite pointless.

Accordingly it is sufficient, in the case of either set of coördinates, merely to alter slightly the correct value of C, so as to make the computed range agree with the observed range, although we thus introduce a slight distortion into the rest of the trajectory.

But, of course, the fact that the same equations of motion are thus used in *computing*, regardless of which coördinate system is used in *applying the computed results to the earth*, does not at all mean that the two coördinate systems are identical. By using the same approximate equations *in computing* in both coördinate systems, we merely eliminate the necessity of deciding which of the *precise* equations would be easier to compute with, for we compute with neither set of precise equations. But there still remains the question of which system is the one in which this approximation is the most justifiable, and which system is the easiest in which to apply the computed results to the actual curved earth.

If and when a new and more precise G-function is tabulated, the Roth method (or the Moulton, with the extra terms of equations 5) should then be used for all work (such as antiaircraft), in which accurate data are desired with respect to intermediate points on the trajectory. Until then it is not worth while to perform the extra work of either of these methods.

The chief object of this present paper is to place on record the fact that the old tangent plane is no longer the official datum of modern ballistics, and to compare the precise equations of both coördinate systems, thus demonstrating that the customary practice of using the flat-earth equations (3), in place of the precise equations (4 or 5), introduces no more error in the modern curved coördinate system than it did in the old tangent-plane system. There is a persistent misapprehension on this particular point.

Prof. Moulton's "New Methods in Exterior Ballistics" (p. 10), the Encyclopedia Brittanica (Vol. XXX, p. 393), and "Physical Bases of Ballistic Table Computations" (p. 14) apparently assume, throughout their discussion of curvature of the earth, that the old coördinate system is still in use, for there exists under the modern system no problem of curvature of the earth, and no curvature correction to be applied, both of which are discussed by these authorities. However, it was perfectly correct for the last two named to give the former convention, as they were written prior to the change; and Prof. Moulton is excusable, as he left the service before the change, and never had it called to his attention. Yet these three books are apt to cause a misapprehension in this connection, to readers who do not realize the situation with respect to each.

Capt. Bennett's "Introduction to Ballistics" (p. 171) correctly states:

> "Since recent range tables are based on observations of firing corrected to equal map altitudes, the ranges that would be obtained in a plane tangent to the earth at the gun are never found at any stage of the problem . . . In short, the curvature of the earth may be said to be accounted for by being ignored."

"A Course in Exterior Ballistics," W. D. Doc. No. 1051, describes the modern coördinate system in great detail on pages 35, 45 and 46, and says on pages 67 and 68:

> "In the Ingalls-Siacci system of ballistics, the practice was to compute a trajectory by means of rectangular-coördinate equations of motion based upon the assumption of a flat earth, and then apply the trajectory to the curved earth by referring it to a rectangular grid, whose x axis was tangent to the earth at the gun. . . .
>
> "But the present convention is that the trajectory, computed exactly as before, is now applied to the curved earth by referring it to the orthogonal curvilinear grid discussed in Chapter VII.
>
> "Under the tangent system, curvature was taken out of the range-firing range to get the tangent range, all range-table computations were based on the tangent range, and then the curvature correction had to be added in again.
>
> "Under the curved system, the curvature correction does not have to be either taken out or put in. Inasmuch as the *system* is curved, curvature of the *earth* may be disregarded."

All modern firing tables of the U. S. Army now contain substantially the following language on page iii of the introduction:

> "The ranges listed in column (1) and throughout the table are 'curved' ranges; that is, they are regarded as measured along the surface of the sphere concentric with the earth and passing through the gun.* Such measurements are understood to be made from the gun to the points where the trajectories pierce this spherical surface; or in case of the correction tables for the height of target, to points on this surface directly above or below the target. These points are all at the same height above sea-level as the gun, and hence may be called 'level points'. It should be emphasized that no correction for curvature of the earth should be applied to these ranges."

BUT probably the best description of the modern system is that given on pages xviii and xix of the Introduction to the 1924 Ballistic Tables:

> "The trajectories used in the formation of these tables were computed for rectangular coördinates except that gravity was taken as acting always perpendicular to the axis of X and the density used was that corresponding to the height y above the surface of the earth rather than above a tangent plane . . . The correction

*Note. In view of the discussion of ellipticity earlier in this article at the suggestion of Aberdeen, this clause should be rephrased somewhat as follows: "they are regarded as measured along a level-surface passing through the gun"; and the word "spherical" in the succeeding sentence should be changed to read "level."

to the range due to curvature of the earth is negligible in these tables . . . It is partly allowed for in the original computations by keeping the force of gravity, g, constant and perpendicular to the X axis throughout the trajectory, and by using for the density that corresponding to y considered as the altitude above the surface of the earth rather than as the height above the tangent plane. For these reasons, the ranges given herein may be considered as measured on the curved surface of the earth. Any further correction that may be necessary will be incorporated in the ballistic coefficient, C, for each range and elevation."

In other words, the trajectories are computed according to equations 3, in a rectangular Cartesian system, and then the results are applied to the actual earth as though our x-axis were the curved surface of the earth and our y-lines vertical; the slight errors, introduced by this distortion of our Cartesian grid, compensate each other almost exactly, any net error being assimilated into the value chosen for C.

These quotations should establish, without question, the fact that the modern convention is to use the curved coördinate system of Fig. 2; but, in computing, to treat the curved grid as though it were Cartesian, i. e., by using equations 3.

Of course there exists no official ukase, binding anyone to compute their trajectories in this manner. A scientist should not be hampered by any set rules as to coördinate systems, any more than he should be hampered by a set requirement to use calculating machines, logarithms or slide-rules in his work, *provided that he expresses the results in the official manner.*

Thus, if a computer wishes to take all the unnecessary trouble, there is no ruling of the War Department to prevent him from calculating back from the observed range to find the point where the trajectory pierced the tangent plane, then using the tangent-plane range as the basis for computing the trajectory and then locating the terminus of the trajectory at the point where y equals not zero, but rather $-x^2/2R$, which involves a more difficult interpolation to get y.

But the present practice is to avoid all this trouble (as Bennett points out) by simply ignoring the curvature of the earth, and by conducting all computations exactly as though the earth were flat. This is the saving which is effected, at no loss of precision, by the modern coördinate system.

Yet, even among those who recognize the convenience and official status of the modern system of coördinates, there exists a persistent feeling (subconscious, at least) that when one gets to computing long ranges, one must revert to the old tangent-plane system in order to secure precision; whereas, in fact, the old system was no more precise than the modern, and the error in precision in either system is so slight as to be negligible in the face of the greater errors inherent in the present G-function.

To sum up. The use of the curved co-ordinate system, shown in Fig. 2, but treated exactly as though it were Cartesian, is the system at present in use in the U. S. Army, is more convenient than the old tangent-plane system, and is at least as precise.

The Dependence of Ordnance on Industry

"IF modern war could be fought with the instrumentalities produced in the ordinary business life of the nation, our procurement planning would be simple. If automobiles alone could determine the issue, America would be sure of winning. If structural steel was all that was necessary for success, America would be invincible.

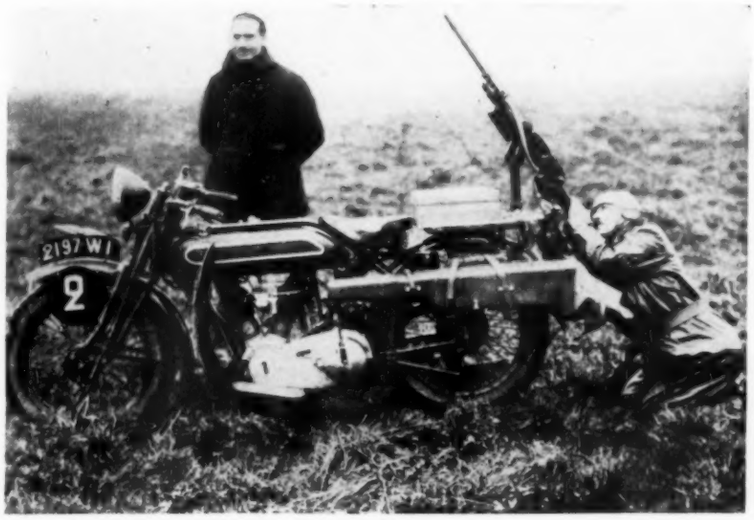
"But, in the complex science of modern war, the weapons used are such as cannot be profitably produced in time of peace and modern wars are not won by automobiles, or structural steel. We must convert the automobiles into tanks, gun tractors, ammunition trucks and the like and we must convert the structural steel into cannon and shells. We must convert civilian airplanes into combat planes, armed and fitted to carry bombs, for without these weapons, as has been so aptly said, all our aircraft could do to an enemy would be to give him a dirty look.

"When war broke out we found ourselves scurrying hither and thither with no definite procurement plans, with no idea where material could best be procured, and the result was confusion multiplied—such confusion as the country had never seen and which we hope may never again occur. The result was the wastage of billions of dollars and, what was of even more importance, the loss of thousands of lives due not only to inadequate training but to inadequate equipment.

"From all this stress and confusion, however, certain cardinal principles of a modern war were thrust upon us. We can envisage the future as being very largely a mechanized affair—a war of machines. More and more will the air forces be brought into play—more and more will contrivances for protecting men from machine gun and automatic fire be used. At the present time, the principal device we have for such protection is the tank, and it takes no stretch of the imagination to foresee that, in a future combat, we shall have thousands of tanks, and that there will be battles of tank battalions against tank battalions; for offensive weapons are being developed to such an extent that something of that sort will be necessary to enable any living human being to reach the enemy's line.

"All these matters form an essential part of the procurement planning of my office, and large numbers of the finest minds in the commercial life of the nation are constantly studying them and solving the problems presented. It is work that is unheralded and unsung—a quiet peace-time study and solution of problems that will inevitably arise in time of war—but the time, energy and brain-power being devoted to this study is of as great benefit to the nation in its national defense program as any assistance that could be given by any war-time activity within or without the army. The nation owes you men a debt of gratitude and will be under a constantly increasing obligation to you as the years go by and the procurement planning is further perfected."—*From an address by Col. Charles B. Robbins, Assistant Secretary of War, at a joint meeting of the Philadelphia Post, Army Ordnance Association, and the Chamber of Commerce, Philadelphia, Pa., May* 24, 1928.

Speed's The Thing In Warfare



Machine Gun on Motorcycle Mount

Latest mechanized equipment of the French Army displayed at military maneuvers at Satory Camp included this anti-aircraft machine gun mounted on a motorcycle.

War Gas for Quick Use

This, the new motorcycle war gas carrier of the French Army, is a late adaptation for the administration of gas in warfare.

Will the Tommies Double Time on Motorcycles?

This three-wheel motorcycle was made for the British War Office and is here shown negotiating a steep bank. It is said that this equipment may be used for infantry movement in the British mechanized Army.

Tracer Ammunition

Part II: Tracer Mixtures and Materials

Capt. S. P. Meek,* Ord. Dept., U. S. A.

A ROUND of tracer ammunition consists essentially of components which are identical with those of a round of ball ammunition with the exception of the bullet. While at times it has been found necessary to use propellant powers of different characteristics for tracer and ball cartridges, this is not true at the present time, and there is no reason why a powder cannot be developed which would be equally suitable for both ball and tracer. The primer and cartridge case are, of course, identical for ball and tracer, except that the tracer case is blackened as a means of identification.

When, however, we come to the bullet, we find a very radical difference. Instead of a lead slug covered with a gilding metal jacket, we find that the tracer bullet consists of either two or three metallic components, depending upon the design of the bullet. These components consist of the jacket, the lead point slug and the container, which in some designs of bullets is omitted. The container, or in case the container is omitted, the bullet jacket is packed with a substance known as "tracer mixture." Tracer mixtures have various formulae depending upon the color, visibility, range of trace and other characteristics which it is desired to obtain from the bullet. To this problem of tracer mixtures Frankford Arsenal has devoted a great deal of time and money, particularly during the last five years.

THE characteristics of tracer mixtures which may be classed as essential are: (1) That the mixture be of such a character that it can be readily loaded into a container or jacket. (2) That it be of such a character that it is possible of ignition, either by the impinging on it of the hot gases resulting from the discharge of the cartridge or by some relay mixture. (3) That having once been lighted that it trace with a visible flame. (4) That this flame be continuous from the point at which the trace starts to the end of the designated range of trace. (5) That when fired from a gun having a given angle of elevation the center of impact of a group of tracer bullets and a group of ball cartridges be identical at some specified range. (6) That the tracer mixture be made entirely of materials of domestic manufacture from raw materials produced in this country. (The last requirement, it may be mentioned, is an essential of all military supplies due to the strategic necessity of insuring a continuity of supply in case of a maritime blockade of this country.)

The desirable characteristics of tracer mixture, although not essential, as were the foregoing, are: (1) That the material be waterproof. (2) That the material be non-hygroscopic. (3) That it be exceedingly easy of ignition. (4) That it be non-explosive. (5) That it give as high a visibility as possible. (6) That it give as long a trace as possible. (7) That the trajectory of a bullet loaded with this mixture conform closely to the trajectory of a ball cartridge throughout its entire range of trace. (8) That the materials from which it is manufactured be cheap and abundant.

Referring to the third requirement under desirable characteristics, I may state that this characteristic has never been obtained by Frankford Arsenal in a tracer mixture which is otherwise suitable. A mixture having all of the required, and many of the desirable characteristics, can be made, but the characteristics of maximum length of trace and ease of ignition are incongruous, and in fact, constitute a direct antithesis of one another. Any mixture which traces for a long time must burn slowly. Any mixture which burns slowly must be difficult of ignition. Consequently, we have been forced to entirely abandon the idea of ease of ignition in order to secure other desirable characteristics.

This being the case, it becomes necessary to place in the bullet some substance which is easy of ignition and which in turn will relay the flame on to the tracer mixture proper. Substances of this class are known as "igniters."

An igniter has as essential characteristics the following: (1) It *must* be easy of ignition. (2) It must be reasonably sure to relay its flame to the tracer mixture. (3) It must be made of domestic materials.

The desirable characteristics of igniters are: (1) Non-hygroscopicity. (2) Cheapness and abundance of materials. (3) Ease of manufacture.

Unfortunately, however, so far have we gone in the direction of length of trace with the tracer mixtures that we have not been able to manufacture an igniter which will have both of the first two essential characteristics quoted. While we can make an igniter that will be reasonably sure to ignite from the powder gases resulting from the discharge of the cartridge, such an igniter will not universally relay its flame to the tracer mixture as it is too quick burning. On the other hand, we can manufacture an igniter which once it has ignited is reasonably sure to relay the flame. An igniter of this type, which is much slower than the first igniter mentioned, is, however, rather difficult of ignition. To overcome this, we have had to resort, in certain cartridges, to what is known as the "sub-igniter system" of ignition.

A sub-igniter is a substance the characteristics of which are midway between those of an igniter and a tracer mixture. It is a substance which will not be ignited by the hot gases on discharge but which is sufficiently easy to ignite that it will be almost invariably ignited by the flame of a hot quick igniter. On the other hand, its rate of burning is so slow that once it has been ignited, it is fairly sure to relay its flame on to the tracing mixture proper.

REVERTING now to tracing mixtures, there are certain substances which must enter into their composition. The first two are an active oxidizing agent and a substance which can be readily oxidized and which burns with a luminous and visible flame. An example of such a tracer mixture is the mixture used in the Model 1917 caliber .30

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tracer cartridge, which mixture consisted of barium peroxide, a very active oxidizing agent, and powdered magnesium, a substance which burns readily with a visible flame.

Barium peroxide is only one of many oxidizing agents which have been experimented with and which can be used in tracer mixtures. Among others, I might quote—barium nitrate, sodium nitrate, potassium nitrate, and (if the explosive element be disregarded) barium chlorate, potassium chlorate, potassium perchlorate, potassium dichromate, potassium permanganate and a large number of other active oxidizing agents. A number of these named as well as other oxidizing agents have been used and are now used in the manufacture of the various types of tracer ammunition made at Frankford Arsenal.

When we come to the material to be burned, magnesium occupies a unique place among chemical elements. It alone, among the chemical elements, converts a disproportionate amount of its energy of combustion into visible light rays as compared with the common characteristic of converting most of the energy of combustion into heat or infra red rays. Other substances have as a matter of course been experimented with. Among them I might mention aluminum, iron, zinc and certain organic substances. None of them, however, compare with magnesium for efficiency.

Having adopted an oxidizing agent and magnesium as two of the essential ingredients, the third required is some sort of a binder. If the oxidizing agent and reducing agent be packed in the bullet without a binder as was done in the Model 1917 tracer, there is a strong tendency to discontinuity of the column of material. There is also a tendency to shattering under the impact of discharge with resultant malfunctioning. If, however, the substances are coated with some binder which under the loading pressure used will weld into a homogeneous mass of considerable tenacity and strength, both of the undersirable characteristics mentioned above, namely, discontinuity of column and tendency to shattering, are obviated.

A great many experiments have been performed at Frankford Arsenal using various binders. The first tests made were with linseed oil. Castor oil, paraffin, carnauba wax, glycerol palmitate, various stearates, oleates and palmitates were experimented with, also a great many of the metallic based organic esters. The most efficient, fortunately, proved to be a very readily obtainable substance, and this is now being used in all tracer mixtures manufactured at Frankford Arsenal.

The next substance which must be considered is a fuel or deterrent. The object of such a substance is, of course, to slow down the rate of burning and to steady it. It is not necessary to say a great deal about this subject but it may be dismissed with a few words, namely, that the best substance of this type which we have found has been certain organic salts of the metallic bases corresponding to the oxidizing agents used.

WITH these four substances, we have all the essential ingredients of a tracer mixture. However, such a mixture can be improved very materially by the addition of a fifth substance, known as a "brightening agent." In searching for brightening agents, we took into consideration all of the commonly known phenomena of luminescence. One of the first principles in common ordinary use which we endeavored to apply to the problem of tracer mixtures was the common Welsbach or incandescent gas mantle. This mantle is made by saturating cloth in a solution of cerium and thorium nitrates in a proportion of 98.5 to 1.5, and then incinerating the cloth, thus transforming the nitrates into the oxides. Based on the above, cerium-thorium mixtures and, conversely, thorium-cerium mixtures were tried in tracers but it was found that they gave a very low efficiency. Also, they were rare substances and hard to get.

Another principle which was more or less successfully applied was that of the Nernst lamp which consists essentially of silicates, oxides and other refractory salts of yttrium and zirconium. Yttrium and zirconium mixtures were tried in tracers but with only mediocre success. Besides these substances, one of them coming from Sweden and the other from Burma, did not satisfy the requirement that all ingredients used be from a domestic supply.

The commonly known calcium or lime light principle was investigated but it was found that calcium salts had characteristics which rendered them exceedingly undesirable in tracer mixtures, notably an active tendency towards deliquesence.

A number of other blind leads were followed before the one which led to eventual success was first experimented with. By dint of patient experimentation, extensive reading of reference works and considerable original research, a substance was at last found that not only materially brightened the flame and intensified the color but also gave about 33⅓ per cent. additional length of trace. There were drawbacks found to its use. The first lot of ammunition loaded with it deteriorated in a year to complete worthlessness, but the idea was too good to abandon and fresh experiments were initiated to remedy its undesirable characteristics. Success at last crowned the efforts of the research force and this ingredient is now used in all tracer mixtures manufactured at Frankford Arsenal.

The ingredients of the sub-igniter are practically identical with those of the tracer mixture. Different oxidizing agents are used and different proportions of the various substances, but the character of each ingredient and the purpose of it remains the same.

The materials composing the igniter are similar to the first two of the materials composing a tracer mixture. An igniter consists essentially of the correct proportions of magnesium and oxidizing agents to enable it to ignite very readily and at the same time give the maximum possible chance of relaying the flame on to either the mixture or sub-igniter.

In production manufacture, tracer mixture is made up in lots of approximately eight hundred pounds at a time, enough to load 200,000 rounds of caliber .30 tracer bullets. To avoid the danger that would inevitably ensue from handling such large quantities at one time, the actual manufacturing unit is about four pounds. After 200 of these four-pound units have been made up, they are carefully blended together, and a representative sample taken and sent to the Inspection Department. After several preliminary tests bullets are loaded from the sample and given a firing test before any of the lot is used for production loading. The igniters are made up in smaller lots, an igniter lot consisting of approximately two hundred pounds, enough to load 200,000 caliber .30 tracer bullets.

(This is the second of a series of articles on Tracer Ammunition by Captain Meek. The third and concluding article will be published in the July-August issue.)

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tracer cartridge, which mixture consisted of barium peroxide, a very active oxidizing agent, and powdered magnesium, a substance which burns readily with a visible flame.

Barium peroxide is only one of many oxidizing agents which have been experimented with and which can be used in tracer mixtures. Among others, I might quote—barium nitrate, sodium nitrate, potassium nitrate, and (if the explosive element be disregarded) barium chlorate, potassium chlorate, potassium perchlorate, potassium dichromate, potassium permanganate and a large number of other active oxidizing agents. A number of these named as well as other oxidizing agents have been used and are now used in the manufacture of the various types of tracer ammunition made at Frankford Arsenal.

When we come to the material to be burned, magnesium occupies a unique place among chemical elements. It alone, among the chemical elements, converts a disproportionate amount of its energy of combustion into visible light rays as compared with the common characteristic of converting most of the energy of combustion into heat or infra red rays. Other substances have as a matter of course been experimented with. Among them I might mention aluminum, iron, zinc and certain organic substances. None of them, however, compare with magnesium for efficiency.

Having adopted an oxidizing agent and magnesium as two of the essential ingredients, the third required is some sort of a binder. If the oxidizing agent and reducing agent be packed in the bullet without a binder as was done in the Model 1917 tracer, there is a strong tendency to discontinuity of the column of material. There is also a tendency to shattering under the impact of discharge with resultant malfunctioning. If, however, the substances are coated with some binder which under the loading pressure used will weld into a homogeneous mass of considerable tenacity and strength, both of the undersirable characteristics mentioned above, namely, discontinuity of column and tendency to shattering, are obviated.

A great many experiments have been performed at Frankford Arsenal using various binders. The first tests made were with linseed oil. Castor oil, paraffin, carnauba wax, glycerol palmitate, various stearates, oleates and palmitates were experimented with, also a great many of the metallic based organic esters. The most efficient, fortunately, proved to be a very readily obtainable substance, and this is now being used in all tracer mixtures manufactured at Frankford Arsenal.

The next substance which must be considered is a fuel or deterrent. The object of such a substance is, of course, to slow down the rate of burning and to steady it. It is not necessary to say a great deal about this subject but it may be dismissed with a few words, namely, that the best substance of this type which we have found has been certain organic salts of the metallic bases corresponding to the oxidizing agents used.

WITH these four substances, we have all the essential ingredients of a tracer mixture. However, such a mixture can be improved very materially by the addition of a fifth substance, known as a "brightening agent." In searching for brightening agents, we took into consideration all of the commonly known phenomena of luminescence. One of the first principles in common ordinary use which we endeavored to apply to the problem of tracer mixtures was the common Welsbach or incandescent gas mantle. This mantle is made by saturating cloth in a solution of cerium and thorium nitrates in a proportion of 98.5 to 1.5, and then incinerating the cloth, thus transforming the nitrates into the oxides. Based on the above, cerium-thorium mixtures and, conversely, thorium-cerium mixtures were tried in tracers but it was found that they gave a very low efficiency. Also, they were rare substances and hard to get.

Another principle which was more or less successfully applied was that of the Nernst lamp which consists essentially of silicates, oxides and other refractory salts of yttrium and zirconium. Yttrium and zirconium mixtures were tried in tracers but with only mediocre success. Besides these substances, one of them coming from Sweden and the other from Burma, did not satisfy the requirement that all ingredients used be from a domestic supply.

The commonly known calcium or lime light principle was investigated but it was found that calcium salts had characteristics which rendered them exceedingly undesirable in tracer mixtures, notably an active tendency towards deliquesence.

A number of other blind leads were followed before the one which led to eventual success was first experimented with. By dint of patient experimentation, extensive reading of reference works and considerable original research, a substance was at last found that not only materially brightened the flame and intensified the color but also gave about 33⅓ per cent. additional length of trace. There were drawbacks found to its use. The first lot of ammunition loaded with it deteriorated in a year to complete worthlessness, but the idea was too good to abandon and fresh experiments were initiated to remedy its undesirable characteristics. Success at last crowned the efforts of the research force and this ingredient is now used in all tracer mixtures manufactured at Frankford Arsenal.

The ingredients of the sub-igniter are practically identical with those of the tracer mixture. Different oxidizing agents are used and different proportions of the various substances, but the character of each ingredient and the purpose of it remains the same.

The materials composing the igniter are similar to the first two of the materials composing a tracer mixture. An igniter consists essentially of the correct proportions of magnesium and oxidizing agents to enable it to ignite very readily and at the same time give the maximum possible chance of relaying the flame on to either the mixture or sub-igniter.

In production manufacture, tracer mixture is made up in lots of approximately eight hundred pounds at a time, enough to load 200,000 rounds of caliber .30 tracer bullets. To avoid the danger that would inevitably ensue from handling such large quantities at one time, the actual manufacturing unit is about four pounds. After 200 of these four-pound units have been made up, they are carefully blended together, and a representative sample taken and sent to the Inspection Department. After several preliminary tests bullets are loaded from the sample and given a firing test before any of the lot is used for production loading. The igniters are made up in smaller lots, an igniter lot consisting of approximately two hundred pounds, enough to load 200,000 caliber .30 tracer bullets.

(This is the second of a series of articles on Tracer Ammunition by Captain Meek. The third and concluding article will be published in the July-August issue.)

Editorial

"A Munitions Manufacturers' Lobby"

THE great majority of Daughters of the American Revolution in their recent annual congress at Washington gave additional evidences of the national importance of their organization and its function in advancing sound, constructive thought on the preparedness policy of the nation. Through the National Defense Committee of the D. A. R. the so-called Big Navy Program was given a very welcome boost, although the program itself was later scuttled and sunk under severe opposition from other sources.

This by way of exordium to a very amusing incident during the discussion of the matter before the D. A. R. Congress. During the debate on the action of its National Defense Committee one of the opposition forces of the D. A. R. intimated, according to *The New York Times*, that "a munitions manufacturers' lobby was using the patriotic (sic. D. A. R.) organization to further its interests."

The news that there is such a thing as a "munitions manufacturers' lobby" is great stuff! We wish the lady who referred to it had described it more at length. We wish that this bugaboo had been given substance and form so that one might be able to identify it. The ridiculousness of the intimation is not quite congruous with what we have always understood a Daughter of the American Revolution to typify. Coming from anyone who should be in a position to know the facts the charge is grotesque.

The term lobby is fast becoming a favorite epithet for anyone or any group voicing its opinion on pending state and national legislation. That insidious means are and have been used to effect certain legislation is not to be denied, but that there is a "munitions manufacturers' lobby" is piffle for no other good reason than that in all this wide land there is scarcely such a thing as a commercial munitions manufacturer. Other than a few makers of sporting guns and ammunition and small arms, America has no commercial munitions industry and under the existing state of things never will have in peace times. The good lady who made the charge is obviously under the impression that there are a thousand and one manufacturing plants in America crying for contracts for 16-inch guns, whereas the fact is that there is not one single American manufacturer—other than the Government itself—prepared to take such an order unless a plant be built or remodeled, equipment installed, and personnel trained to do the job. Apparently some folks believe that to purchase a battery of antiaircraft guns for the living room mantel all one need do is turn to the classified section of the telephone directory and there, amid the psychiatrists and beauty parlors, under "munitions manufacturers" locate a dozen or more willing takers. We suggest that they try it.

No, good lady, if our line of reasoning is correct there must first be "munitions manufacturers" before there can be a "lobby" of them. "Potential munitions manufacturers" is probably what you mean, but still you are in water far beyond your depth when you intimate that they maintain a lobby. For potential "munitions manufacturers" takes in everybody from the chap who in peace times makes milady's nail polish to the gigantic automobile factory that grinds 'em out one a minute. It may even include your own good self for who knows but that if there is another war you may be among the first to offer your services; and if you only sew socks for soldiers you are a member of the great unholy—"munitions manufacturers." For munitions, you know, on no less an authority than Noah Webster himself is that all-embracing term for "whatever materials are used in war."

The Army Ordnance Association has been trying—and, we are proud to say, with some degree of success—to keep alive a knowledge of what munitions are so that it will take less time, and thereby cause less loss of lives, to create a munitions industry in America whenever the call to the colors again comes. In this work the Association is merely coöperating with the Government in trying to carry out the terms of the National Defense Act. Should war ever come—and none more ardently than the individuals who comprise the A. O. A. conscientiously hopes that it will not—the members of this Association will turn from peace to war just as they did ten years ago and they'll do it, we hope, with twice the speed and the job will be successful—far more successful than in 1918.

And so if there is such a thing as that munitions manufacturers' lobby we believe we would know about it. The funny thing is there isn't and so a straw man is blamed because the naval authorities felt it incumbent to build more ships.

Adequate national defense measures often have a great deal to be said on both sides of the question. Maybe the Navy program of 1928 as originally announced was far too pretentious. Maybe it was not. But if we are going to argue such things—and discussion is always helpful—let's not get reckless with our statements of fact. Smoke screens are intended for use against an enemy and not among ourselves.

The New Picatinny

WITH an appropriation of slightly more than two and a quarter million dollars, the work of rebuilding the Picatinny Arsenal, near Dover, N. J., is now under way. The arsenal was laid low in July, 1926, when its neighbor, the Lake Denmark Naval Ammunition Depot, was destroyed. Funds for the rebuilding of the Army establishment were provided by the Congress several months ago.

During the time which has elapsed since Picatinny was demolished thorough studies have been made as a result of which the rebuilding of the establishment will proceed along advanced lines. New buildings will be erected at points more advantageous than the old, more modern equipment

will be installed, and hazardous areas will be more efficiently grouped and guarded. So that in replacing the old every possible improvement both in kind and location will be incorporated in the new.

With all the loss occasioned by the Lake Denmark disaster, certainly insofar as Picatinny itself and its function are concerned, the catastrophe was something of the nature of a blessing in disguise. Having weathered the storm in some fashion, Picatinny now embarks on a voyage of added usefulness and importance to the Army and the nation. For Picatinny is not just another Army post, nor is it simply another explosives plant getting back on its feet after a blow. It is both these and more because it is the very essence of our entire national defense scheme. In battle men without guns are so much cannon fodder and guns without ammunition are as useful as scented soap in the Sahara. The design and development of artillery ammunition for the Army is the responsibility of Picatinny. Hence the imperative necessity that Picatinny have at its disposal the most efficient facilities possible.

Throughout its history as an experimental and manufacturing establishment this arsenal has been characterized by the eminence of its staff—military and civilian. Today it has a staff of scientists and technicians of the highest ability. With this complement of mental resources given adequate facilities and modern means for the performance of their important work there is every reason to believe that army artillery ammunition—which in the not distant past was regarded as a stepchild even by black legs who should have known better—will continue to keep step with other munitions developments. The new Picatinny will reflect even greater credit on the efficiency of personnel and plant, and will enhance the value of this establishment to the chemical and explosives industry, to the Army and to the nation as a whole.

The Universal Draft Again

HON. J. MAYHEW WAINWRIGHT, member of Congress from New York and former Assistant Secretary of War, has introduced in Congress a bill to create a commission to draft a bill providing for the mobilization of all the resources of the nation in time of war, including labor, industry, agriculture, capital and potential military forces. The commission would be bi-partisan and would include in addition to four members each of House and Senate the Secretaries of War, Navy, Agriculture, Commerce and Labor and "four other persons not holding any official or governmental position with the Federal Government and selected with a view to represent in a general way the views of labor, industry, capital, agriculture and the professions respectively." Thus is attempted a solution of one of the knotty problems of munitionment in war.

It would seem that such a commission, assuming that it is to be strictly a fact-finding body, might arrive at some worth while conclusions. Certainly the recurring demand that the profit be taken out of war goes too deeply to the very root of our national existence to be pushed aside without "open covenants openly arrived at." To air all the ramified phases of the question, submit them to the cold light of actual experience and arrive at sound conclusions is a worthy procedure in every field of activity, the most equitable method of defending the nation not excepted.

But the commission, if it ever comes into existence, will have to be sane and practical. Open-mindedness will have to be its cardinal attribute. Preconceived opinions that the doughboy comes off the field of battle with next to nothing, oftentimes not even his entire self, and that the "war lord" in his ease at home profiteers at the expense of his more patriotic brother, should find no place in these deliberations. Underlying the entire structure are basic economic considerations which the best-intentioned commission under the sun cannot disregard. Indeed these, as in the World War, are so deep-rooted that it may be better to have no metes and bounds laid out in advance of an emergency, but rather depend on the conscience and ability not only of those whose office it is to prosecute war but those, civilian and soldier as well, whose duty it is to execute it.

Money is not the only medium by which the price of victory is measured. Those who remain at home to make the sinews of war have their victories and defeats no less than those who man the guns, and the defeats and losses at home are in many cases as severe as those of actual conflict. If there are millions of doughboys who because of war are sick of it, there are proportionately as many stay-at-homes who have not yet gotten on their feet and many more have long since perished. So the problem has many aspects which this proposed commission would be in a position to analyze.

Whether it could possibly formulate regulations to prevent some profiteering would be just as difficult as to prevent some deserters. The real American, if his role is to stay at his plant and supply munitions, will do his best to fulfill that responsibility fairly to his country and to himself; and the real American whose role is to go forth to battle will do his best to fulfill that responsibility. Being what we are, we cannot but feel that whenever necessity again demands the rank and file will do their best—conscientiously, speedily and willingly, law or no law—and experience has shown that where real team work is wanted such things as esprit, public opinion and innate fair play have got extreme coercive measures beat thumbs down.

Educational Orders

THE United States Chamber of Commerce, among other noteworthy accomplishments at its recent annual meeting in Washington, adopted the following resolution:

"Modern war is a war of machines and requires these machines in numbers heretofore undreamed of. The capacity of government arsenals for the manufacture of these machines is small compared with the volume required in time of war. In order that industrial enterprise may in times of peace become familiar with munitions manufacture and be prepared to do its part in war production it is essential that the National Defense Act should be so amended as to permit the Secretary of War to place with industries orders of an educational character for equipment, munitions, and accessories. In this manner only can commercial concerns obtain familiarity with war requirements and have their place in industrial war plans of the War Department."

Industrial America continues to give whole-hearted support to this pressing problem. The action of the Chamber is another indication of what Hanford MacNider, former assistant Secretary of War, so aptly phrased, "The increasing interest all over the nation in industrial preparedness is a frank declaration to the world that we not only want peace but that we intend to have it."

Personnel

Col. Chas. Elliot Warren, Treasurer, A. O. A., Completes Long Military Service

FORTY-FIVE years of unbroken military activity ended with the retirement, April 8, 1928, of Col. Chas. Elliot Warren, Treasurer of the Army Ordnance Association since its organization in 1919, banker, clubman, and distinguished soldier, who relinquished command of the 514th Antiaircraft Artillery, U. S. Army Reserve, and was transferred to the Auxiliary Reserve.

Col. Chas. Elliot Warren

The holder of many military decorations, Colonel Warren, who was born in New York City April 9, 1864, a lineal descendant of Richard Warren of the Mayflower, at 19 years entered the Old Seventh Regiment of New York City as a private, but rose rapidly through the enlisted and commissioned grades to become a colonel and one of New York's most widely known military figures. He is the present Colonel-Commandant of the picturesque Veteran Corps of Artillery, the oldest independent military organization in New York State. For exploits in the Spanish-American War he was awarded the War Cross of Honor from the Seventh Regiment. His National Guard service also included duty with the Twelfth New York Infantry and he later served on Brigade and Division staffs of the Guard.

During the World War he won his coloneley from the rank of major, rendering important services in the office of the Secretary of War and in the Ordnance Department. It was for this that he was awarded the Distinguished Service Medal. Before the War Colonel Warren had completed the first Plattsburg Business Men's Camp in 1915 with high honors and the following year had won a major's commission at the second encampment.

Colonel Warren, who is chairman of the Advisory Board of the American Exchange Irving Trust Company and a director of numerous large corporations, holds the New York National Guard medal for long and faithful service. His awards also include the Legion of Honor (France), the Medaille de la Reconnaissance (France), the Conspicuous Service Cross of New York State and others.

He is a member of the Society of the Cincinnati, Society of Mayflower Descendants, New York Historical Society, Sons of the Revolution, Society of Colonial Wars, Military Society, War of 1812, and the Huguenot Society.

On the occasion of his transfer to the Auxiliary Reserve, Colonel Warren was the recipient of many congratulations on his lengthy military career. Maj. Gen. C. C. Williams, Chief of Ordnance, U. S. A., wrote:

"These many years of active interest in military affairs bespeak a patriotic zeal which is an inspiration to all of us who know your fine spirit of service. Your excellent service as an Ordnance Officer during the World War and your untiring interest since then as an officer and director of the Army Ordnance Association, together with your many other patriotic activities, make yours a record of which all of us are proud."

Colonel Westervelt Retires

LIEUT. COL. WILLIAM I. WESTERVELT, Ord. Dept., U. S. A., one of the most brilliant and well known officers of the Ordnance Department, and now on duty at Governors Island, has been ordered to his home to await retirement at his own request and after thirty-two years' service.

Colonel Westervelt is known to Ordnance experts and military men generally as the president of the board which bears his name and the deliberations of which have been the guiding influence of the post-war development, construction and equipment of the artillery matériel of the United States Army. The present study and experimentation in mechanization in warfare is due in great part to the conclusions drawn by this board, particularly in the development of mobile artillery.

It was within a month after the Armistice of November 11, 1918, that General Pershing ordered Colonel Westervelt—then a Brigadier General, National Army—together with a number of other prominent officers, to convene at Chaumont to make a study of the armament of the various nations involved in the World War, with the view to developing the proper armament, calibers, and type of matériel, kinds and proportion of ammunition, and methods of transport of the artillery to be assigned to a field army.

The board first met on January 12, 1919, and for many months devoted itself to the study. During this time, Ordnance manufacturing plants in France, Italy, aud Great Britain were visited, a close study made of German matériel and methods, and all the prominent officers of artillery of our own army were brought before it to give their recommendations and experiences.

The results of the findings of the Westervelt Board brought about the reorganization of our own artillery into its present division of types and calibers of light, medium and heavy matériel, and an intense experimentation and study into improved matériel, types of which have been constructed by the Ordnance Department for test purposes, and many of them adopted.

Colonel Westervelt, a native of Texas and a graduate of the United States Military Academy, class of 1900, was serving as a major of Field Artillery when America entered the World War. His rise to that rank had been markd by important posts at Army Ordnance depots and he had served on the technical staffs of large arms manufacturing plants.

Landing in France, July 10, 1917, as adjutant of the 1st Field Artillery Brigade, 1st Divi-ion, Colonel Westervelt was promoted to Colonel August 5, becoming Chief of Material Section and, for a short time, the commanding officer of Army Artillery, First Army, A. E. F. Appointed brigadier-general April 12, 1918, he was detailed as Assistant Chief of Field Artillery, A. E. F.

In that post he served until the Armistice, winning the Distinguished Service Medal. The citation read: "For exceptionally meritorious and distinguished service. As Assistant to the Chief of Artillery, through his initiative, organizing ability, and comprehensive knowledge of the technique and tactics of Artillery in all its branches, and particularly through his complete knowledge of Artillery matériel, he has rendered services of exceptional value to the Government."

His other decorations include Officer of the Legion of Honor (France), Companion of St. Michael and St. George (Great Britain), and Commander of the Crown (Italy). Among his campaign awards are the Victory Medal, the Philippine Campaign Medal, and service ribbons of the Spanish-American War and Mexican Border Campaign.

He is a member of the University Club (New York), Racquet Club (Philadelphia), and St. Botolph Club (Boston). After his return from Europe Colonel Westervelt reverted to his permanent grade of major July 31, 1919, was promoted to lieutenant-colonel September 28, 1919, and transferred to the Ordnance Department July 1, 1920.

Col. James W. Benét

COLONEL James W. Benét, Ord. Dept., U. S. A., Retd., a charter member of the Army Ordnance Association, well known for his preëminent service to the Ordnance Department for many years, died at his home in Westtown, Pa., March 30, 1928.

Colonel Benét was born at Richmond, Ky., July 16, 1857. He was appointed to the U. S. Military Academy from the District of Columbia and was graduated in 1880. He served in the Ordnance Department until his retirement in 1921.

During the Spanish American War he was stationed at the Bethlehem Steel Works as an Inspector of Ordnance and during the World War he was in command of the Augusta Arsenal, Augusta, Ga. From 1919 until his retirement he was in command of the Watervliet Arsenal, Watervliet, N. Y.

Members of Picatinny Arsenal Civilian Staff Honored for Bravery

ON APRIL 3, 1928, honors were extended three civilian employees of the Picatinny Arsenal for bravery at the time of the Lake Denmark Ammunition Depot explosion, July 11, 1926. Those commended were Messrs. E. Williams, assistant superintendent of production; I. Yamin and T. E. James, assistant fire chiefs, who were cited in General Orders No. 1, Office of the Chief of Ordnance, dated March 6, 1928. A meeting of the principal employees of the Picatinny Arsenal was held on April 3rd when the order was read publicly.

Honored for Bravery at Picatinny
Left to right: E. Williams, T. E. James and I. Yamin.

The citations, which are identical for the three heroes, are given in the order as follows:

"The following named civilian employees are commended for heroic conduct, beyond the call of duty, upon the occasion stated, namely:

"E. Williams, Assistant Superintendent of Production, Picatinny Arsenal, Dover, N. J. For heroism on July 11, 1926, during the explosions at the Lake Denmark Naval Ammunition Depot, near Dover, N. J. Mr. Williams, one of a party of eight men, entered the burning area at 6:30 A. M. to search for First Lieutenant George W. Bott, Jr., United States Army, who was known to have been in the powder factory at the time of the first explosions late the preceding afternoon. Throughout the search they were in close proximity to burning magazines and exposed to frequent explosions of large-caliber shells and small-arms ammunition. While there was still possibility of more serious detonations, and at the risk of their lives, they located the body of Lieutenant Bott and with great difficulty succeeded in removing it from the wreckage to a point outside of the danger zone."

Transfers of Regular Ordnance Officers

THE following changes of station of regular officers have been announced in recent War Department orders:

Col. T. L. Ames from Hdqrs. 1st Corps Area, Boston, Mass., to Office, Assistant Secretary of War, Washington, D. C.

Col. J. W. Joyes from Army Industrial College, Washington, D. C., to Army War College, Washington, D. C.

Lt. Col. L. B. Moody, from War Department, General Staff Corps, Washington, D. C., to Panama Canal Department, C. Z.

Lt. Col. E. M. Shinkle from Hawaiian Department, Honolulu, T. H., to Office, Chief of Ordnance, Washington, D. C.

Lt. Col. G. H. Stewart from August Arsenal, Augusta, Ga., to Hawaiian Department, Honolulu, T. H.

Maj. H. S. Aurand from Command and General Staff School, Fort Leavenworth, Kans., to Hdqrs. 5th Corps Area, Fort Hayes, Columbus, Ohio.

Maj. C. H. Bandholtz from Massachusetts Institute of Technology, Cambridge, Mass., to Office, Chief of Ordnance, Washington, D. C.

Maj. R. N. Bodine from Fort Sam Houston, Tex., to Hdqrs. 1st Corps Area, Boston, Mass.

Maj. A. S. Buyers from Hdqrs. 5th Corps Area, Fort Hayes, Columbus, Ohio, to Aberdeen Proving Ground, Md.

Maj. DeR. C. Cabell from Watertown Arsenal, Watertown, Mass., to Hdqrs. 7th Corps Area, Fort Omaha, Neb.

Maj. R. W. Case from Hdqrs. 7th Corps Area, Fort Omaha, Neb., to Army War College, Washington, D. C.

Maj. O. J. Gatchell from Command and General Staff School, Fort Leavenworth, Kans., to Office, Chief of Ordnance, Washington, D. C.

Maj. R. L. Gaugler from Hdqrs. 3rd Corps Area, Washington, D. C., to Hdqrs. 4th Corps Area, Fort McPherson, Ga.

Maj. A. G. Gillespie from Hdqrs. 6th Corps Area, Chicago, Ill., to Army War College, Washington, D. C.

Maj. J. B. Gillespie from Militia Bureau, Washington, D. C., to Baltimore District Ordnance Office, Baltimore, Md.

Maj. G. W. Graham from Army Industrial College, Washington, D. C., to Buffalo District Ordnance Office, Watervliet, N. Y.

Maj. K. B. Harmon from Rock Island Arsenal, Rock Island, Ill., to Office, Chief of Ordnance, Washington, D. C.

Maj. C. T. Harris, Jr., from Office, Chief of Ordnance, Washington, D. C., to Hdqrs. 2nd Corps Area, Governors Island, N. Y.

Maj. J. S. Hatcher from Frankford Arsenal, Philadelphia, Pa., to Hdqrs. 3rd Corps Area, Baltimore, Md.

Maj. T. J. Hayes from Hdqrs. 9th Corps Area, San Francisco, Calif., to Hdqrs. 8th Corps Area, Fort Sam Houston, Tex.

Maj. E. S. Hughes from Army War College, Washington, D. C., to War Department, General Staff Corps, Washington, D. C.

Maj. H. R. Kutz from Hdqrs. 3rd Corps Area, Baltimore, Md., to Inspector General's Department, Governors Island, N. Y.

Maj. G. F. Lemon from Savanna Ordnance Depot, Savanna, Ill., to Benicia Arsenal, Benicia, Calif.

Maj. J. Q. MacDonald from Frankford Arsenal, Philadelphia, Pa., to Rock Island Arsenal, Rock Island, Ill.

Maj. R. L. Maxwell from Ordnance Officer, 1st Cavalry Division, Fort Bliss, Texas, to General Staff Corps, Fort Bliss, Texas.

Maj. R. R. Nix from Office, Assistant Secretary of War, Washington, D. C., to Army War College, Washington.

Maj. C. E. Partridge from Benicia Arsenal, Benicia, Calif., to Command and General Staff School, Fort Leavenworth, Kans.

Maj. J. B. Rose from Army War College, Washington, D. C., to Watertown Arsenal, Watertown, Mass.

Maj. C. B. Thummel from Hdqrs. 7th Corps Area, Fort Omaha, Neb., to Command and General Staff School, Fort Leavenworth, Kans.

Maj. G. P. Wilhelm from Hdqrs. 8th Corps Area, Fort Sam Houston, Texas, to Philippine Department, Manila, P. I.

Maj. J. H. Woodberry from Army Industrial College, Washington, D. C., to Command and General Staff School, Fort Leavenworth, Kans.

Maj. W. C. Young from Fort Bragg, N. C., to Hdqrs. 6th Corps Area, Chicago, Ill.

Capt. J. K. Christmas from Pittsburgh District Ordnance Office, Pittsburgh, Pa., to Office, Chief of Ordnance, Washington, D. C.

Capt. J. W. Coffey from U. S. Military Academy, West Point, N. Y., to Curtis Bay Ordnance Depot, Curtis Bay, Md.

Capt. R. C. Coupland from Wright Field, Dayton, Ohio, to Office, Chief of Ordnance, Washington, D. C.

Capt. R. Z. Crane from Manila, P. I., to Ordnance School, Watertown, Mass.

Capt. J. M. Erwin from Office, Chief of Ordnance, Washington, D. C., to Cleveland District Ordnance Office, Cleveland, Ohio.

Capt. E. L. Ford from Ordnance School, Watertown, Mass., to Office, Chief of Ordnance, Washington, D. C.

Capt. T. C. Gerber from Hdqrs. 5th Corps Area, Fort Hayes, Ohio, to Manila, P. I.

Capt. W. R. Gerhardt from Ordnance School, Watertown, Mass., to Frankford Arsenal, Philadelphia, Pa.

Capt. J. A. B. Gibson from Fort Sam Houston, Texas, to Office, Chief of Ordnance, Washington, D. C.

Capt. F. I. Gilbert from Hdqrs. 1st Corps Area, Boston, Mass., to Militia Bureau, Washington, D. C.

Capt. R. E. Hardy from Buffalo District Ordnance Office, Watervliet, N. Y., to Hdqrs. 3rd Corps Area, Baltimore, Md.

Capt. G. R. Hartriek from Army Industrial College, Washington, D. C., to Watervliet Arsenal, Watervliet, N. Y.

Capt. C. F. Hofstetter from Langley Field, Va., to Wright Field, Dayton, Ohio.

Capt. J. G. Holmes from Fort Monroe, Va., to Aberdeen Proving Ground, Md.

Capt. T. W. Holmes from Springfield Armory, Springfield, Mass., to Panama Canal Department, C. Z.

Capt. R. L. Hubbell from Ordnance School, Watertown, Mass., to Raritan Arsenal, Metuchen, N. J.

Capt. T. M. Jervey from Aberdeen Proving Ground, Md., to Kelly Field, Texas.

Capt. I. A. Luke from Picatinny Arsenal, Dover, N. J., to Office, Chief of Ordnance, Washington, D. C.

Capt. D. G. McGregor from Bridgeport District Ordnance Office, Springfield Armory, Mass., to Fort Leonard Wood, Md.

Capt. C. H. Menger from Birmingham District Ordnance Office, Birmingham, Ala., to Aberdeen Proving Ground, Md.

Capt. C. H. Morgan from University of Pennsylvania, Philadelphia, Pa., to Frankford Arsenal, Philadelphia, Pa.

Capt. E. A. Murphy from San Antonio Arsenal, San Antonio, Texas, to Aberdeen Proving Ground, Md.

Capt. J. W. Orcutt from Erie Ordnance Depot, LaCarne, Ohio, to Fort Bragg, N. C.

Capt. N. W. Osborn from Army Industrial College, Washington, D. C., to Hdqrs. 1st Corps Area, Boston, Mass.

Capt. F. F. Reed from Army Industrial College, Washington, D. C., to U. S. Military Academy, West Point, N. Y.

Capt. H. W. Rehm from Brown University, Providence, R. I., to Fort Monroe, Va.

Capt. H. N. Rising from Ordnance School, Watertown, Mass., to Picatinny Arsenal, Dover, N. J.

Capt. H. F. Safford from Office, Chief of Ordnance, Washington, D. C., to Frankford Arsenal, Philadelphia, Pa.

Capt. W. R. Slaughter from Aberdeen Proving Ground, Md., to Langley Field, Va.

Capt. S. R. Stribling from Kelly Field, Texas, to Office, Chief of Ordnance, Washington, D. C.

Capt. W. F. VanderHyden from Office, Assistant Secretary of War, Washington, D. C., to Rock Island Arsenal, Rock Island, Ill.

Capt. H. S. Wilkins from Baltimore District Ordnance Office, Baltimore, Md., to Office, Chief of Ordnance, Washington, D. C.

Capt. V. Wilson from Office, Chief of Ordnance, Washington, D. C., to Fort Bliss, Texas.

Capt. W. I. Wilson from U. S. Military Academy, West Point, N. Y., to Fort Sam Houston, Texas.

1st Lieut. G. H. Bardsley from Fort Monroe, Va., to Picatinny Arsenal, Dover, N. J.

1st Lieut. W. E. Becker from Office, Chief of Ordnance, Washington, D. C., to Hdqrs. 9th Corps Area, San Francisco, Calif.

1st Lieut. W. S. Broberg from Rock Island Arsenal, Rock Island, Ill., to U. S. Military Academy, West Point, N. Y.

1st Lieut. H. J. Conway from Aberdeen Proving Ground, Md., to Ordnance School, Watertown, Mass.

1st Lieut. D. N. Hauseman from Ordnance School, Watertown, Mass., to Birmingham District Ordnance Office, Birmingham, Ala.

1st Lieut. R. J. Hogan from Ordnance School, Watertown, Mass., to Erie Ordnance Depot, LaCarne, Ohio.

1st Lieut. J. L. Holman from New York District Ordnance Office, New York, N. Y., to San Antonio Arsenal, San Antonio, Texas.

1st Lieut. Myron Leedy from Fort Eustis, Va., to Ordnance School, Watertown, Mass.

1st Lieut. Urban Niblo from Ordnance School, Watertown, Mass., to Springfield Armory, Springfield, Mass.

1st Lieut. U. J. L. Peoples from Curtis Bay Ordnance Depot, Curtis Bay, Md., to Ordnance School, Watertown, Mass.

1st Lieut. C. W. Reed from Fort Leonard Wood, Md., to Ordnance School, Watertown, Mass.

1st Lieut. H. Shaler from Raritan Arsenal, Metuchen, N. J., to New York District Ordnance Office, New York, N. Y.

1st Lieut. C. E. Whitney from Cleveland District Ordnance Office, Cleveland, Ohio, to Fort Leonard Wood, Md.

2nd Lieut. F. C. Devenbeck from Aberdeen Proving Ground, Md., to Ordnance School, Watertown, Mass.

2nd Lieut. E. H. Harrison from Ordnance School, Watertown, Mass., to Fort Eustis, Va.

2nd Lieut. H. W. Miller from Picatinny Arsenal, Dover, N. J., to Ordnance School, Watertown, Mass.

2nd Lieut. F. J. Stagliano from Fort Banks, Mass., to Ordnance School, Watertown, Mass.

2nd Lieut. A. Willink from Ordnance School, Watertown, Mass., to Frankford Arsenal, Philadelphia, Pa.

Spring Training for Ordnance Reserve Officers

AS OF May 1st, the following Ordnance Reserve Officers have been ordered to active duty for spring training:

Cincinnati District Ordnance Office: May 20th to June 2nd. 2nd Lieut. John M. Wallace.

Benicia Arsenal: May 20th to June 2nd. Capt. Raymond B. Silverman.

Baltimore District Ordnance Office: May 6th to May 19th. Capt. Paul Anderson.

Aberdeen Proving Ground, Md.: June 3rd to June 16th. Maj. Clark S. Robinson.

Picatinny Arsenal: May 20th to June 2nd. Majs. Stephen K. Plume and William R. Wright; Capts. Amos T. Pagter, Henry G. Roberts, and George T. Tomasky; 1st Lieut. Clifton R. Hovland; 2nd Lieuts. William S. Gould, Amos W. Huyette, and John F. Ohlson.

Watervliet Arsenal: May 20th to June 2nd. Maj. James L. Smyser, 1st Lieut. John H. F. Madgett, and 2nd Lt. Vernon G. Engelman.

Watertown Arsenal: May 20th to June 2nd. Majs. Hiram B. Guise, G. Elkins Knable, Weaver H. Rogers, and Fay B. Williams; Capt. Edmund B. Moore; 1st Lieuts. Arthur P. Bliss, John S. Carter, Levi C. Eddy, Gordon C. Fowler, and Charles L. Yost; 2nd Lieuts. Forrest F. Lange, and Lyman L. Tremaine.

Springfield Armory: May 20th to June 2nd. Lt. Cols. Aaron L. Mercer, and Virgil A. Root; Maj. Gustave E. Behr, Jr.; Capt. Reuben E. Goho; 1st Lieuts. Fred Hanss, and Thomas L. Hapgood; 2nd Lieuts. Edward B. Allen, Walter W. Cummings, David Kaufman, and Charles H. McCann.

Frankford Arsenal: May 20th to June 2nd. Lt. Col. Frederick E. Wright; Majs. Arthur E. Bellis, Edward P. King, and Ralph E. Parker; Capts. Percy C. Avery, Vladimir V. de Svenshnikoff, Charles W. Francis, and Edward E. Tanguy; 1st Lieuts. Herbert S. Karch, Chester Mueller, and Carlyle H. Strand; 2nd Lieuts. Erling A. Arentz, Warren G. Coryell, Richard C. Dehmel, and Frank H. Hebard.

Washington, D. C.: May 1st to 14th, Lt. Col. Harry A. Knox, and May 13th to 26th, Maj. Andrew F. Carlin.

Professional

Two More Types of Guns Added to Armament of Cavalry

UPON recommendation of Major General Herbert B. Crosby, Chief of Cavalry, two new weapons are to be added at once to the armament of cavalry regiments. They are the 37-mm. guns for employment against hostile armored cars, light tanks and machine gun nests, and the antiaircraft machine guns mounted on cross-country cars. These two types of weapons are to augment the machine guns of the regimental machine gun troop. The antiaircraft section of the machine gun troop will be equipped with three cross-country cars upon each of which is mounted an antiaircraft machine gun, and the one pounder section will be provided with three 37-mm. guns packed on horses. As it is possible that all cavalry of the future will have mobile tanks, the inclusion of one-pounders to combat these tanks becomes imperative.

The addition of these two weapons to the already greatly increased armament of cavalry, with its recently doubled artillery fire-power, is in keeping with the constant endeavor being made by the Chief of Cavalry to utilize most advantageously all mechanical devices particularly suited to mounted combat. Other weapons recently authorized for the cavalry are: armored car squadron, light tank company, and air service.

The armored car squadron is a distinct addition to the new war strength cavalry division. It consists of a squadron headquarters and three armored car troops, with a total strength of 36 armored cars. The personnel provided is eighteen officers and 260 enlisted men. The troop of 12 armored cars is organized into three platoons of four armored cars, with a troop personnel of five officers and 84 enlisted men. In peace-time but one troop will be authorized for the cavalry division. Although armored cars were used but little during the World War, it is evident that they may prove of great value for cavalry, particularly on reconnaissance, advance guard duty and screening. It is thought that our armored cars should be highly mobile, of light or medium weight with comparatively light armament. The armor will be proof against small arms only, so the cars will depend principally upon mobility for their protection. Undoubtedly armored cars will increase the radius of reconnaissance and save horse flesh for cavalry under some circumstances.

The recent addition of the light tank company to the cavalry division, both in peace and war is also of importance. It is believed the light tank now being developed by the Ordnance Department will be sufficiently fast and mobile for use with the cavalry. To be of value for such use it should be capable of 25 to 30 miles an hour on roads and 12 to 15 miles an hour across country.

Experience in the First Cavalry Division, Fort Bliss, Texas, has indicated that an observation squadron of airplanes should be an integral part of a cavalry division. Heretofore it has been planned to attach such a squadron whenever necessary. This has proved unsatisfactory and a division air service now has been incorporated into the cavalry division organization, both war and peace strength. The air corps unit consists of an observation squadron of thirteen airplanes and a photographic section. The War Department is of the opinion that the battle value of cavalry increases with the breadth of vision bestowed by aircraft. In future operations, the air service will save cavalry by making distant reconnaissance and by early indication to the cavalry of the location of hostile enemy forces to be engaged. It will also furnish mounted troops valuable assistance in reconnaissance of routes.

Basic Principles for Experimental Mechanized Force

THE War Department has instructed the Commanding General, Third Corps Area, that in planning the work of the Experimental Mechanized Force, which will be assembled at Fort Leonard Wood (Camp Meade), Maryland, about July 1st, the following basic principles will be followed:

"The completely mechanized force is a self-contained unit of great mobility, great striking power, and limited holding power.

"It should not be considered as a divisional unit but rather, because of its special characteristics, as a force of special mission in the accomplishment of which and in exploitation of which troops of infantry or cavalry divisions will coöperate.

"The role of the mechanized force is essentially offensive.

"Tanks are the principal attack elements of the mechanized force.

"The tactics of the force as a whole shall be predicated

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upon supporting and assisting the attack of the tank elements, and upon quick consolidation and securing or exploiting the success gained in the tank attack.

"Other arms are added as auxiliaries, to furnish the element of holding power which tanks lack, security, maintenance of command, fire support, facility of movement, and supply.

"Surprise, speed, and depth of penetration in the attack should characterize the operations of a mechanized unit. Its tactics should be devised to assure these.

"All members of the force should be imbued with a spirit of the utilization of the speed which modern equipment will afford.

"The force should be regarded as a tactical as well as technical laboratory. While it will have to operate this year with considerable obsolescent automotive equipment, it is nevertheless expected that much information as to tactics and technique will be derived which will be of benefit to further development.

"The capabilities and limitations of such a force should be studied not only in the light of the bulk of obsolescent matériel as furnished this year, but also in the light of a force equipped throughout with matériel of the more modern experimental types furnished. For this purpose the four M1 tanks to be furnished should be used to the maximum."

A New Small Prism Binocular

MILITARY men today clearly recognize as of vital importance that field instruments to be carried by the individual man should be not merely scientifically good, but also convenient in size and light in weight. Yet even convenient portability and excellent quality is of lessened value if the instrument is such that it takes time to adjust and bring into action.

This is perhaps especially true in the matter of binoculars which hitherto have always been large and made of metal. It is therefore of interest to record that a small prism binocular (Mirakel), the housing of which is made of a material similar in appearance to bakelite, hard and durable, but very light in weight. In fact, this binocular is designed so small that the 7X model weighs only 6 ounces net, and is only 2½ inches in height, thereby making it possible to carry the glass in the shirt pocket. In addition, the advantage—readiness for instant use—is also a characteristic of this binocular, as it is so designed that after an initial adjustment to the eyes, all objects even as close as 25 feet will be in sharp and clear vision at all times without further refocusing. That is, when once set for a man's eyes, it is set for life for any reasonable distance, and one can raise it to his eyes and instantly see the object he wishes to spot without going into any preliminary re-adjustments.

This fact is also of value in mounted reconnaissance work for three reasons: First, being carried in the pocket this binocular is always ready for instant use, and in using it only one hand is required; secondly, it is more comfortable to carry than a big three-pound glass dangling over the shoulder in a stiff leather case; and thirdly, owing to this avoidance of violent jarring there is no likelihood of the prisms shaking out of adjustment. This last advantage is not to be ignored, as in most binoculars the prisms are not permanently fixed in position, as any adjustment necessary for aligning the glass is accomplished

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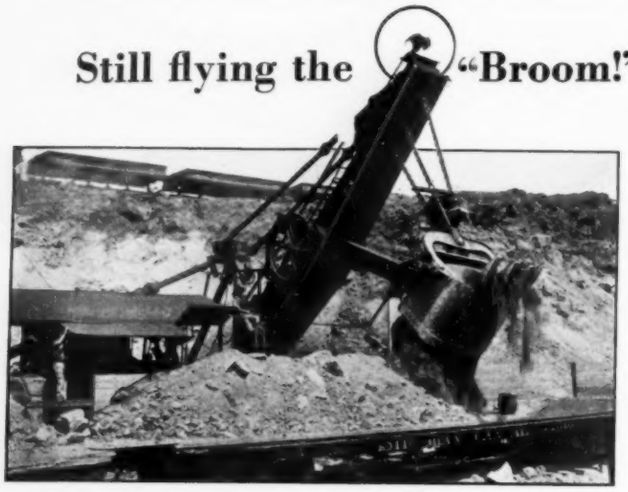

Old-timers who worked on the Panama Canal can well remember "The Broom," the emblem that waved proudly from the boom of the shovel holding the output record.

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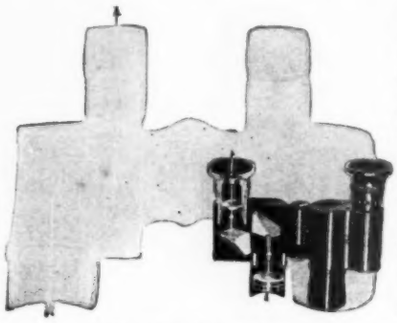
by moving the prisms. In the binocular mentioned, however, the prisms are rigidly imbedded in the composition, all adjustments being made externally on the eccentric eye tubes.

For airplane use, where it is often necessary to use a glass while wearing heavy gloves, it is obviously impossible to employ a big glass in a bulky case. This little glass, whose weight of 6 ounces is negligible, can be carried by a cord around the neck and slipped in any pocket, and used without danger of accident by one hand even when heavily gloved. Owing to the vibration of the plane it is often desirable to use the 5X rather than the 7X. The weight of this glass is even less—only 5 ounces and its size is also proportionately smaller.



Mirakel Binocular

Showing relative size of 6x30 metal prism binocular and the little 7-power Mirakel binocular.

Of course the factor of convenience is only of interest if the instrument itself really compares favorably with the larger instruments. Tests recently completed by the Frankford Arsenal at the instance of the War Department (under date of June 23, 1927) compared this vest pocket binocular with a standard 6x30 glass, the comparison being extremely favorable to the small glasses, the following points being brought out:

The graphs in the report show that the error against flatness of field (field curvature) is about the same in both glasses (slightly better correction in the case of the Mirakel) but the standard 6X glasses have a much greater amount of astigmatism.

As regards depth of focus the test showed that the Mirakel glasses yielded a field of 4° sharp and clear (without refocusing the eye-piece) while in the case of the 6X glasses, this amounted to less than 2°. Although the objective lenses of the Mirakel are very small, the light transmission is so good that sufficient illumination is attained for nearly all practical uses. Another remarkable feature is that this small glass compares very favorably with the large glass in the all important matter of size of field of view.

It will be seen from the above that as regards sharpness of definition, adequate illumination, and width of field the little glasses are the equal of the large glasses. In view of the Mirakel affording additional advantages, small size, light weight and fixed focus, it appears that this instrument is a real contribution to the equipment of the man in the field.

A New Organization for Infantry Cannon

AN EXPERIMENTAL organization for the Howitzer Company, 29th Infantry, Fort Benning, Georgia, providing for increased personnel, for the purpose of transportation and operation of the recently improved 37-mm. gun and the newly developed 75-mm. mortar, was recently approved by the War Department.

This tentative organization has resulted from preliminary experiment at the Infantry School, Fort Benning, Georgia, and will be effective for a period of one year. Both weapons have more power and materially different characteristics than the World War weapons which they will replace.

The authorized personnel in the experimental howitzer company will be five officers and 197 enlisted men as compared with six officers and 107 enlisted men in the present company. The number of animals will be increased from 23 to 39 and the number of vehicles from 9 to 21. These increases in personnel and transportation are largely due to the increase in the number of weapons. The experimental organization provides for 6 mortars in place of three 3-inch trench mortars, which comprise the high angle fire armament of the present howitzer company. The number of 37-mm. guns remains unchanged.

Present tables of organization provide for one howitzer company to each war strength Infantry regiment. This howitzer company is organized into three platoons, to permit the assignment of one platoon to each battalion in combat. Because of the lack of personnel, the howitzer companies of the Regular Army regiments have been reduced to one platoon each and attached to the headquarter company. The Howitzer Company, 29th Infantry, is the only Regular Army howitzer company in the United States Army.

A. E. S. C. Changes Procedure to Speed National Standardization

EXTENSIVE revision of its rules of procedure to speed industrial standardization work on a national basis is announced by the American Engineering Standards Committee. The chief object in broadening the procedure has been to make it so flexible that it may easily fit all of the varied conditions to be met in the wide range of industrial subjects covered by the Committee's work. The revision is based upon the experience of the Standards Committee during its nine years of activity as a national standardizing body.

Three important changes are made in the procedure. Heretofore, each sectional committee—essentially a joint committee composed of representatives of the various groups interested in the particular work in hand—has acted under the administrative support and direction of one or more of the interested bodies, who are termed sponsors. A sectional committee may now operate autonomously, reporting directly to the A. E. S. C.; or it may act under sponsors as before. The second change recognizes "proprietary" standards and makes possible the revision of such standards within a single organization on condition that it be shown that a standard is acceptable to the groups concerned. This method is particularly applicable to highly specialized fields in which the standard of an organization has already achieved a position of recognized eminence. The third change provides for very simple cases. The approval of standards under such cases is based upon the action of a conference followed by written acceptances of the interested groups.

The revised procedure states that the different methods are founded on the principle that the basic test to be applied in all cases is the fact of the assent, affirmatively expressed, of the groups having substantial interest in the

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standard. Such groups have an inherent right to representation on the body dealing with the subject matter of the standard, but it is not essential that this right be exercised.

The steps in the development on revision of a standard by a sectional committee are:

1. Standardization proposed by responsible body.
2. General conference called by A. E. S. C. to consider proposal and to decide whether the work shall be done; if so, whether the sectional committee shall operate under a sponsor or autonomously.
3. Recommendation of conference acted upon by A. E. S. C.
4. A sectional committee is organized.
5. The make-up and personnel of sectional committee approved by the A. E. S. C.
6. Standard drafted by sectional committee.
7. The draft standard published or circulated for criticism.
8. Proposed standard approved by sectional committee by letter ballot.
9. Proposed standard approved by sponsor, if there be a sponsor, or formally endorsed by at least one coöperating body if the sectional committee is autonomous.
10. Standard approved by A. E. S. C.
11. Standard published by sponsor, or by the A. E. S. C. if sectional committee is autonomous.

The steps in approval of existing or proprietary standards:

1. An existing or a proprietary standard submitted to A. E. S. C. for approval by a responsible body.
2. Investigation of facts regarding consensus through A. E. S. C. agencies; or the development of the acceptability of the standard though a representational committee.
3. Standard approved by A. E. S. C.
4. Standard published.

The steps in the development of a standard by general acceptance:

1. Standardization proposed by a responsible body.
2. Survey of field made, and draft standard produced by working committee.
3. Draft standard considered by general conference.
4. Proposed standard formally accepted by groups concerned.
5. Standard approved by A. E. S. C.
6. Standard published.

The governing authority of the American Engineering Standards Committee is at present vested in 63 men representing 36 national organizations, industrial, technical and governmental. About 350 national organizations are coöperating officially in the work, with 2,100 individuals engaged on various committees. Up to the present time, 111 national standards have been approved, and 164 additional projects representing almost all branches of industry are under way.

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Patents

Brief Descriptions of Inventions of Interest to Ordnance Engineers

Compiled by W. N. Roach, Chief, Patent Section, Office of the Chief of Ordnance

THE following are recently issued patents relating to ordnance matériel:

Ammunition

Maj. Harold M. Brayton, Spec. Res., Picatinny Arsenal, has been granted patent No. 1,662,952 for a locking device for fuzes. In this fuze the plunger is normally held unarmed by means of centrifugal locks and is permitted to creep forward, during flight of the shell, a distance sufficient to overlie the centrifugal locks, so as to prevent them from returning to locking position.

Patent No. 1,663,899 for the "projection of bullets and other projectiles," has been granted to Robert S. Blair. The main object of this invention is to cause the bullet or projectile so to gyrate as to counteract to some extent the force of gravity.

Seigfreid Junghans, administrator of Oskar Junghans, deceased, has been granted patent No. 1,665,666 for a percussion fuze. The invention covers a fuze having a firing pin normally held within the casing and a plurality of explosive elements spaced from each other and out of alignment and a clockwork mechanism for releasing the firing pin to extruded position and moving the explosive elements into alignment.

André Varaud has been granted patent No. 1,665,899, for a mechanical fuze for artillery projectiles. The patent covers a specific clockwork mechanism used for actuating the fuze.

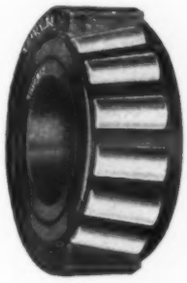
Artillery

George M. Cann, of the Office of the Chief of Ordnance, has been granted patent No. 1,662,977, for a breech-opening mechanism designed to open automatically the breech of a gun having a sliding breech on counter-recoil.

Samuel J. Van Den Bergh, assignor to the firm H. V. Nederlandsche Instrumenten Compagnie, has been granted patent No. 1,663,575, for an antiaircraft fire-control apparatus. In this instrument the telemeter and telescope are so coupled that lateral adjustment of one causes a similar lateral adjustment of the other, but the sighting telescope may be adjusted in elevation independently of the adjustment in elevation of the telemeter.

Thomas A. Conlon, of the Office of the Chief of Ordnance, has been granted patent No. 1,663,796, for a gun mount. The main feature of this invention resides in the novel construction whereby the gun carriage may be supported independently of the springs for firing and supported on the springs in traveling position.

Mr. Conlon has also been granted patent No. 1,665,656, for an azimuth scale with micrometer mechanism. The main purpose of the device is to provide a micrometer



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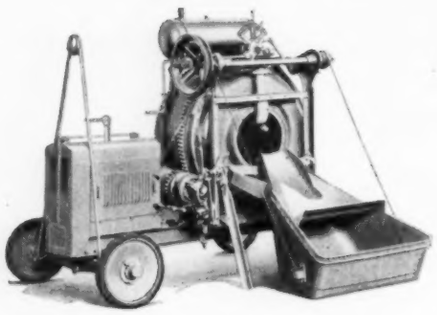

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mechanism which will permit the operator readily and accurately to set the gun to single mils.

Ralph L. Goetzenberger, formerly of Frankford Arsenal, has been granted patent No. 1,664,676, for a fuze setter. The invention contemplates the arrangement of the fuze setter to permit the fuze to be set after the projectile has been placed in a loading tray.

Maj. H. K. Rutherford, Ord. Dept., U. S. A., has been granted patent No. 1,664,948, for a data transmitter and receiver. The main purpose of the device is to permit one operating an instrument, such as a telescope, to indicate to the receiving operator, automatically and independently, the direction and degree of travel of the telescope.

Small Arms

Albert A. Cowan has been granted patent No. 1,659,625, for a rifle and bullet. The object of the invention is stated to be a reduction of friction and an increase in effectiveness. To this end the cartridge chamber and the shell of the cartridge are made rectangular in cross section. The bullet is rifled and is connected to the shell by a special connection.

Patent No. 1,660,590 for a machine gun has been granted to Augustus M. Baldwin. This is a gun having a plurality of bores or barrels, and the inventor provides a container for cartridges which is fed into the gun automatically during operation thereof.

Patent No. 1,660,595 for a machine gun mount has been granted to Joseph F. Butler. This invention contemplates the provision of a mount for holding a number of machine guns and having means for shifting the muzzle of the guns so as to scatter the bullets over a greater or lesser area.

Louis R. Krenek has been granted patent No. 1,661,949, for an interchangeable rifle and shot gun barrel.

Patent No. 1,664,788 for an automatic or self-loading small arm, has been granted to Ludwig Oberhammer. The main object of the invention is the provision of safety means for automatic pistols.

Duncan C. Hooker has been granted patent No. 1,665,961 for a device for cleaning firearms.

Reserve Officers Committee to Report on Reserve Policies

THE War Department has authorized the call to active duty of a committee of Reserve Officers to meet in Washington this summer to report on the operations of Reserve Corps policies. The committee will consist of nine Reserve Officers, one to be selected by the Commanding General of each Corps Area, and will assemble in Washington July 9, reporting to Major General Charles P. Summerall, Chief of Staff, for fifteen days' active duty.

Corps Area Commanders, who will make the selection of members of the committee, have been informed by the War Department that the purpose of convening this committee is to keep the War Department informed of the views of Reserve Officers as to the administrative operation of policies which govern the appointment, assignment and promotion of the Reserve Officers.

No Regular Army Officers will be on the committee, it being the desire of the War Department to have the committee make its study and analysis of Reserve policies and administration and prepare its report uninfluenced and unaffected by opinions of any Regular Army Officers.

Historical

Smokeless Powder in the United States Army

(Through the courtesy of Columbia University Press, publisher of "History of Explosives Industry in America," by A. P. Van Gelder and Hugo Schlatter, ARMY ORDNANCE *is authorized to reprint Chapter V, Part IV. Due to the length of the chapter it has been published serially in this section. The first part appeared in the January-February, 1928, issue.)*

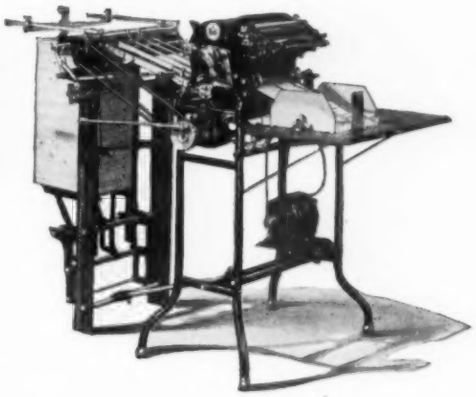
BEFORE contracts for powder of this composition could be let, the Spanish War intervened, during which the army used only brown prismatic powder for its guns. The specifications of September 24, 1898, however, cover powder of this type, and under them the following contracts were given out:

duPont, for 8-inch gun 25,000 lbs., for 10-inch gun 25,000 lbs., for 12-inch gun 100,000 lbs. Laflin & Rand, for 8-inch gun 20,000 lbs., for 10-inch gun 25,000 lbs., for 12-inch gun 100,000 lbs. Dittmar P. Co., for 8-inch gun 25,000 lbs., for 10-inch gun 25,000 lbs., 12-inch gun 50,000 lbs. War Munitions Company, for 8-inch gun 25,000 lbs., for 10-inch gun 25,000 lbs., for 12-inch gun 50,000 lbs. Lewis Nixon, for 8-inch gun 7,500 lbs., for 10-inch gun 15,000 lbs., for 12-inch gun 7,500 lbs.

In addition the California Powder Works had a contract for 140,000 lbs. of this powder which they completed in 1899 and then started on another of 300,000 lbs. This powder was made with an acetone solvent, but it was hard and brittle, not flexible like cordite. The ballistic results were irregular, and when in 1899 a 10-inch gun was blown up by this powder at the Sandy Hook Proving Grounds with fatal results to the gun crew, its manufacture was discontinued.

In the meantime, the Navy had developed its straight nitrocellulose powder and private manufacturers were making it according to the Navy's specifications. After this accident Captain O. B. Mitcham and Lieutenant C. C. Williams (now Chief of Ordnance) were sent to Newport to investigate the merits of the Navy powder. They were favorably impressed with what they saw and with the plants of the private manufacturers and recommended the adoption of a similar powder by the Army.

The Army specifications of December 7, 1899, differ from those of the Navy only in the nitrogen content, which was increased from 12.44 to 12.65 $\pm$ .10 per cent. With increasing knowledge of the character of this powder, the specifications were made more stringent from year to year and definite requirements laid down for the methods of manufacture and for inspection by the Ordnance Department. The Vieille test at 110° C. (later abandoned) was included in 1901, as was also the so-called "German" test at 135° C. In 1902 an explosion test was adopted. In 1903 a physical compression test came into use and the so-called "Ordnance Department Test" at 115° C. In 1906 limits of variations in grain dimensions and limits for



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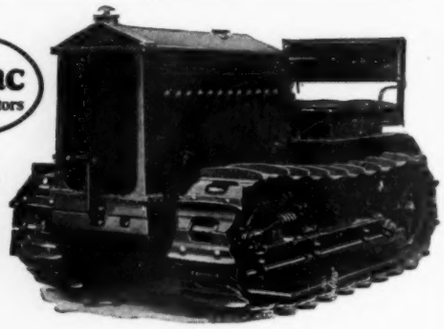

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residual volatiles were prescribed with the adoption of the water-precipitation method of determining these volatiles. In 1909 the Navy's surveillance test at 65.5° C. was adopted, and in 1910 the joint Army and Navy Board that had been appointed in 1906 issued its first set of joint specifications for the two branches of the service. After a short trial with rosaniline as a stabilizer, diphenylamine was adopted for this purpose in 1908 and has remained in use to the present time. Present day specifications lay down detailed directions for the methods to be used in manufacture and provide for rigid inspection from raw materials to finished powder.

The efforts of the Ordnance Department to obtain a powder factory of its own, which had been renewed from time to time since the early part of the 19th century, were finally crowned with success in 1906 when Congress appropriated $165,000 for this purpose. This amount was sufficient for the construction of a plant of a capacity of 1,000 pounds of powder a day, without counting the cost of the land which the army already owned near Wharton in Northern New Jersey. This had been bought in 1880 and a powder depot was located on the tract. A forge had been in existence at this place as early as 1749, and work for the army had been done here during the Revolution. When the land was bought, the possibility of using it for a powder mill had been considered, and a report made in 1882 suggested the draining of the pond on the property to make room for such a mill, but no further steps were then taken.

Major B. W. Dunn was detailed to prepare plans for the smokeless powder factory and he started construction in February, 1907. In June he was ordered to duty with the American Railway Association in connection with the organization of the Bureau of Explosives, and Major Odus C. Horney succeeded him as commanding officer. Actual manufacture at the rate of 1,000 pounds of cannon powder a day was started in the following year. Differing from other powder plants in this country, the Thompson displacement process of nitration was installed. In 1909 arrangements were made to add the production of 250 pounds of small arms powder and after 1910 the plant was gradually increased to a capacity of 9,000 pounds a day. At the same time an experimental plant for the manufacture of military high explosives was erected. When Colonel Horney resigned from the service in 1915 to take charge of the smokeless powder work of the Aetna Explosives Company, Colonel John W. Joyes succeeded him as commanding officer.

Originally all testing of smokeless powder was done at Frankford Arsenal, at first under Captain Pittman and then under Lieutenant (later Colonel) Dunn (now Chief of the Bureau of Explosives, American Railway Association). The Chief chemist was W. J. Williams, F. I. C., F. R. S., an Englishman with previous powder experience, who did valuable work in developing and standardizing testing methods. His assistants were Dr. A. P. Sy (now Dean of Chemistry at the University of Buffalo), Charles Preston Beistle (now chief chemist of the Bureau of Explosives, American Railway Association) and Charles A. Lambert (now superintendent of the Hattiesburg plant of the Hercules Powder Company). In 1903 the testing of cannon powder was transferred to the proving ground at Sandy Hook. Colonel Dunn, Beistle and Lambert were moved to this place, and Dr. W. O. Willcox was engaged as an assistant. At the present time all chemical tests of

cannon powders are made at Picatinny Arsenal, all tests on small arms powder at Frankford Arsenal. Cannon powder is tested ballistically at the new proving ground at Aberdeen, Maryland, which was established in 1918. A range for the testing of small arms has also been established there recently.

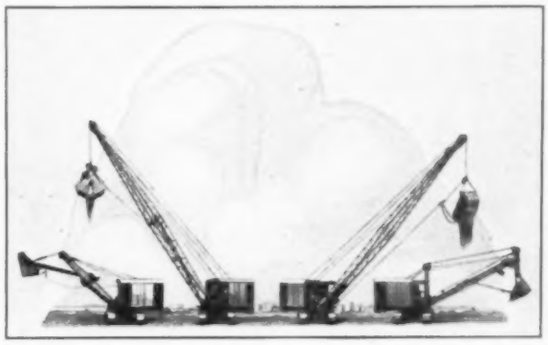
The entry of the United States into the World War brought with it greatly increased demands for smokeless powder, much beyond the capacity of the government or private plants then in existence. The program contemplated the erection of two government-owned plants with a combined capacity of 1,500,000 pounds a day. The duPont company was asked by the War Department to recommend sites for these plants. It sent its engineers over a large part of the country east of the Mississippi River and finally found two suitable locations, one called Old Hickory, near Nashville, Tennessee, on the Cumberland River, and one called Nitro, below Charleston, West Virginia, on the Kanawha River.

The contract for the construction and operation of the former was given to the duPont company, which promptly undertook the work through a subsidiary, the duPont Engineering Company. Construction was started in March, 1918, and the first powder granulated in September, 1918. The plant was built and came into production in units of 100,000 pounds capacity each, all under the direction of E. F. Johnson, engineer and general manager; at the time of the armistice it was producing 500,000 pounds daily.

The plant near Charleston was built under the direction of D. C. Jackling of the Ordnance Department. Colonel Arthur Wass, formerly superintendent of the Picatinny plant and later with the Aetna Explosives Company, was his assistant and chief technical advisor on the explosives work. The duPont company furnished plans for the plant, which were followed in part by the designers, Graham, Anderson, Probst & White, architects of Chicago. The work of construction was contracted to the Thompson-Starrett Company, and after this had progressed to some extent, it was decided to ask the Hercules Powder Company to undertake the operation of the plant. This company at once gathered an organization for the purpose, taking the key men from its own plants and training others in its own laboratories and factories. The operating manager, Leavitt N. Bent, was transferred from the San Diego plant and his principal assistants, John S. Shaw and Charles Hoopes, were transferred from the Union plant and the Wilmington office respectively. At the time of the armistice the plant was 60 per cent. completed and was turning out about 175,000 pounds of smokeless powder a day.

After the war both plants were dismantled and most of the equipment sold. Many buildings, however, were retained and used for the storage of surplus powder. Some of the units, such as acid and cotton purification plants, were sold complete and are still in operation for other purposes. The entire village of Old Hickory (near Nashville) and a large part of the land were purchased in 1924 by the duPont Fibersilk Company for the manufacture of artificial silk. *(The end)*

The Military Medal ($1.00) *and the Civilian Pin* (.50) *of the Army Ordnance Association are for sale to all members. Orders, with remittance, should be sent to the Secretary, Army Ordnance Association, Mills Building, Washington, D. C.*



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Note and Comment

Americanizing the Army

MACHINERY is being introduced into the Army.

Tanks, armored cars, trucks, tractors, cross-country vehicles and other mechanical weapons and conveyances are being experimented with and put into use.

The process is commonly called mechanization. The word, therefore, tends to spread a false conception. A better term would be merely modernization. Or it would be fair to say that the army is being Americanized. . .

Carried to its logical conclusion, the new movement in the War Department means that the whole tactical system must be revised. In the modern war of machinery, infantry, as such, will be used only to occupy positions captured by machine or to advance over country impassable to machinery. The long, thin line of prone infantrymen will pass into history. In modern warfare it is nothing short of absurd for deployed lines of infantry to lie on the military crests of hills, there to be blasted to bits by enemy artillery as the Russian moujiks were in 1915, or to march up to pillbox machine gun nests as the English Tommies did in 1917.

Even slow moving tanks cannot be hit, except by luck, by indirect artillery fire. Machines, capable of traveling cross country and thereby able to avoid mapped roads and cross roads, could advance, carrying guns or squads of infantry until they came within point blank range of the enemy. Indirect fire would not be deadly enough to stop them. If armored against machine gun fire and reasonably protected from the fire of trench weapons like the 37 mm. gun, such machines could advance until within the direct fire of cannon.

Americans have made machinery a means of saving men in industrial life. They can do exactly the same thing in war. Our present endeavor must be to encourage the new spirit that pervades the general staff, to keep the forward looking soldiers in control and relegate the military ancestor worshipers to the clerical positions they can adequately fill.—*Chicago Tribune.*

Pacifist Propaganda

WHILE Congress is in the investigation business it would do well to open an inquiry into the source and identity of propaganda masquerading under the cloak of religious organizations. Some of this propaganda is vicious in the extreme, resorting to gross misrepresentation of the United States and tending to inflame international suspicion and hatred. The propagandists do not hesitate to attribute base motives to American authorities in an effort to undermine public confidence in the Government and Congress. It is reported that some of the most active workers in this propaganda are foreigners and persons recently naturalized and an inquiry might reveal that they are the recipients of funds from foreign sources.

It is a difficult task to provide for the national defense by maintaining the Navy and by developing the merchant marine. This task becomes well-nigh impossible when skillful propaganda, working upon the credulous brains of millions of Americans, concentrates with great force upon members of Congress, intimidating them and confusing them as to the real sentiment of the country. Some of the members of Congress are said to have been threatened with defeat if they dare to defy the propagandists.—*Washington Post.*

War Fundamentalists

THE General Staff of the War Department has reported to Secretary Davis that the most serious consideration should be given to the possibility of greatly increasing the striking power and mobility and effectiveness of the Army by the mechanization of certain units of the nation's present military force. This report represents the General Staff's conclusions after six months of investigation. Though the infantry is still the backbone of land forces, the General Staff is convinced that advances in motorization in the last few years have made possible and advisable the restoration to battlefields through mechanization of the element of movement and surprise which before the World War was operative through cavalry.

This report appears to be merely a reasonable recognition of the fact that we are living in a machine age. That war should be mechanized and motorized seems only natural. At any rate, it is sensible for the Army to be forehanded in this direction while the governments of the world maintain their present attitude toward war and armament.—*Buffalo Express.*

Motor as a National Defense

IN VIEW of American predominance in automotive manufacture, and the employment in this country of 78 per cent. of the licensed automobiles in the world, announcement by the War Department that the General Staff of the Army has been studying mechanization of combat units as a means of making a modern army more mobile and less vulnerable on the field will be received by motor-minded America with particular interest. Mobility of large units of fighting forces has always been of importance in the military history of the world, ancient and modern. And, as the art of war advances, the prompt and rapid movement of troops becomes more important. The value of this factor was shown many times in the World War, when surprise attack in force and prompt response by the defenders of a given point proved of worth above all other considerations.

American arms learned much of the value of the motor during the war in France; learned by observation while America was on the side lines as an observer, and more after this country had thrown its unrestrained efforts in with the Allies. As onlookers we witnessed the saving of Paris through the service of the motor car when taxicabs, motorbusses, private automobiles and every possible means of transport hurried French soldiers forward to plug the gap that threatened to open before a drive upon the capital. As later participants we moved our men and equipment and supplies in great motors. Speed

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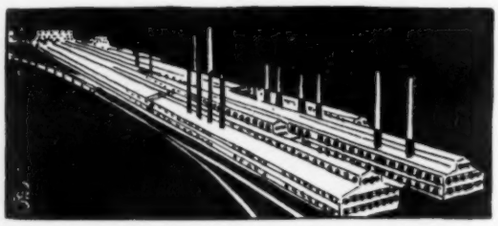

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was the needed thing, and the automobile and the motor truck supplied the need.

But motorization of military forces had only a small beginning in the fighting in Europe. Great strides have been made in the application of this power since the peace of 1918. Troops and guns have taken to this means of transportation in growing numbers. The ultimate, however, has not been approached. So the General Staff has taken the matter up for study.

With 95 per cent. of the 23,253,882 automobiles in use in the United States of domestic manufacture and that number representing more than three-fourths of the motor cars in use in the world, it may be seen that both in the manufacture and in the use of this means of transportation this country occupies a commanding position. Nor is the position of the General Staff in its desire to make the fighting forces of the country more mobile through application of the motor weakened in any way by the fact that a country leading the world so easily in use of motors is no less a leader in motor-mindedness.—*St. Louis Globe Democrat.*

School Pacifists

AN ENCOURAGING sign of the times is the condemnation this week by the Illinois Federation of Women's Clubs of pacifistic agitation in schools and colleges.

Here the pacifist propagandist and proclaimer of theories and doctrines at variance with the fixed policies of this Government have found fertile fields in which to work. The action of the Illinois Federation constitutes an agreeable revelation. It indicates that there are women in the country who do not intend to be deceived by the sophistry of incendiary activities. And it is to the women of the nation that the Government should have the right to look in the matter of establishing and maintaining its political integrity in every sense of the term.

The resolution adopted by the Illinois Federation is strongly couched, decrying the fact that the University of Illinois is constantly being importuned by so-called pacifists, and urging that the federation go on record as protesting this and indorsing the system of military training in schools and colleges.

Women suffer most in any war. They should hate it. They should assist in its rational retrenchment, to the securement of its outlawry as a means of settlement of difficulties and disputes between nations. But because they are the worst sufferers in war is the most powerful reason why they should support adequate preparation for conflict, which means a reduction in the blood and cost of human warfare.

The provisions made by this Government in the matter of defensive preparations are wise provisions. The activities of pacifistic influences in opposition to these measures are harmful to the nation and to its security. Their eradication from the schools and colleges should be imperative, and the action of the Illinois women looking to this end cannot be too highly commended. By following the example of these women, other state federations will honor themselves and inspire the respect and confidence of the country and its Government.—*Cincinnati Enquirer.*

Books

The Staff and the Staff College. By Brevet-Major A. R. Godwin-Austen, O. B. E., M. C. London: Constable and Company, Ltd. 1927. 21 sh.

THOSE who are interested in the problems of national defense and more particularly those who are interested in methods of training for Army staff duty and the higher commands will be interested in reading this account of the development of Great Britain's Staff College at Camberley. The author in a very delightful manner sets forth the growth of this great institution from the time of its inception due to the ideas and efforts of Col. John Gaspard Le Marchant. Starting with a modest beginning in 1799 at High Wycombe as the Senior Department of the Royal Military Academy it soon outgrew its accommodations and moved and grew and moved, until finally it became stabilized at Camberley where it is today.

The many vicissitudes through which it passed, the support it received and the reverses it sustained are of interest in that they parallel the history of many governmental agencies in the United States, which have succeeded, as has this institution, through the perseverance and devotion of their adherents.

The author has been most fortunate in weaving into this history so charmingly the personalities of many who were entrusted with the instruction given and of many who successfully completed the courses. The glimpses of the social life and living conditions as well as of the sports featured are quite vivid and entertaining. This book should particularly appeal to those who have been connected in any way with our own Army Staff College.

1776, A Day-by-Day Story. By Jonathan Rawson. New York: Frederick A. Stokes Company. 1927. $3.00.

HINDSIGHT is more accurate than foresight. Men's actions are praised or condemned by the happening of events subsequent to the action taken. History should be written at long range. But after all it is interesting to read of conditions as they were when events were actually happening. That is what Rawson has given us in his Day-by-Day Story of 1776. The important events in all the colonies and Canada are unfolded as they took place. Intimate acquaintance is established with directors of affairs. Washington, Franklin, the Adamses and others are quoted, as well as the pertinent acts of the various colonies and Continental Congress. History tells us about Bunker Hill, Yorktown and Valley Forge, but Moore's Creek Bridge, Three Rivers and Pell's Point also have their interesting heroes. The despised and deposed British governors were trying to regain their colonies with promises and were also plotting with the restless Indians and Tories for uprisings against the frontiers. The day-by-day stories are interesting in form and excellent in substance.

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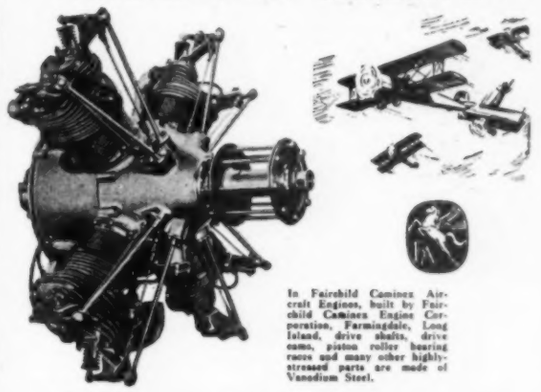

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A History of the Foot Guards to 1856. By Major H. L. Aubrey-Fletcher, D. S. O., M. V. O. London: Constable & Co., Ltd. 1927. 31 sh. 6d.

MAJOR AUBREY-FLETCHER felt that the existing regimental histories of the Foot Guards did not present adequately the story of these historic organizations and that their history was not known as extensively as it should be. Therefore he undertook to prepare this history of their active service which in an unbiased manner records the engagements in which they were participants and the part they played in the success or failure of the undertaking.

The history of the Foot Guards being, with the exception of India, a history of the British Army it was a stupendous task which the author undertook. That he was well qualified for the work this volume bears testimony for it is excellently arranged and delightfully written.

He has omitted much which would have added color to the story, such as: customs, uniforms, equipment, and striking personalities which are to be found in existing regimental histories. It may be said that these omissions made it all the harder to produce a work which would be of interest to other than the professional soldier interested in tactics and strategy. The book does not suffer however because of its scope being limited in this way. On the contrary it is full and interesting.

Sufficient contemporary political history is given to indicate the cause of the various campaigns and the effects of their resulting outcomes.

It is especially gratifying to find such a complete collection of excellent maps and diagrams. These are the work of the author to whom great credit is due for more often than not the military historian omits this very essential feature of such books. It may be very favorably compared with Steele's "American Campaigns" which is conceded by many to be most excellent.

The Royal Inniskilling Fusiliers in the World War. By Sir Frank Fox, O. B. E. London: Constable & Co. 1927. 21 sh.

SIR FRANK FOX has written many histories concerning the British Army and this book demonstrates why he is so successful in these undertakings. It also makes apparent the reaon why a history of any British regiment is a history of the British Army. This regiment was expanded to thirteen battalions which were distributed throughout the army and so participated wherever the army did. A regimental history which recounts the outstanding feats of arms of individual members together with the military honors won by them and which records the name and rank of each member who made the supreme sacrifice for his country, as this one does, finds favor with combatant and non-combatant alike and will be equally prized by both.

The British system of maintaining a peace-time cadre which may be expanded for war purposes without losing its identity and thus instill the new soldiers with traditions which have endured through the centuries has much to recommend it to those responsible for army organization for peace or war. The advantage of this is clearly demonstrated by the author, who shows how quickly the recruit was imbued with the regimental esprit de corps and fought and suffered accordingly.

This is a delightful history of the Inniskilling regiment together with a brief, clear outline of the whole course of

the war which makes it quite remarkable. It is surprisingly complete and compact. A second volume now in preparation is to contain the history of the regiment prior to the World War thus making its entire history complete in two volumes.

The Spanish-American Frontier: 1783-1795; The Westward Movement and the Spanish Retreat in the Mississippi Valley. By Arthur Preston Whitaker. New York: Houghton Mifflin Company. 1927. $3.50.

A VERY clear understanding is obtained from this thorough and authoritative history of the intrigue and diplomacy concerning the western frontier of the United States during the twelve years concluding with 1795. The author has made extensive investigations of available sources in order to obtain the true history of this period in which the Mississippi River, the western frontier, played such an important role. Dr. Whitaker analyses the character of the famous and notorious personages who had much to do with the settlement of the vexatious boundary questions. The formal treaties with the Indian "Nations" and the agreements with the fur traders are typical of the period and interestingly recounted. The land jobbing schemes which were launched and the attitudes of the several state legislatures involved have not been extensively recorded heretofore. In the persent volume that feature of our early history is ably presented together with a clear and complete picture of the great difference between the civilizations represented by the rough backwoodsman of the west and the courtly diplomats of the Spanish Throne. It is a decidedly valuable addition to the history of the development and expansion of the nation.

Peace or War? By Lt. Commander J. M. Kenworthy, M. P. New York: Boni and Liveright. 1927. $2.50.

IN this book Commander Kenworthy, formerly a British naval officer, and now a leader of the Labor party in Parliament, describes the war of the future as an attack on entire civil populations in a successful attempt to show the devastating effects of warfare with modern weapons. It is to be feared that his emphasis on the potentiality of gas and air attack will not be recognized by the civilian, in spite of his vivid language, when one considers that in England as well as other countries "the bow-and-arrow mentality predominates once more" among leaders of the armed forces. It is the country whose soldiers succeed best in replacing the experiences of the last war with a fresh point of view who will have the jump on the other fellow. But this book is an effective plea for peace, and even if the author's solution may not provide the panacea for this great ill, it is of enormous service in frankly analyzing the world politics of today from the point of view of possible danger of war.

The Rough Riders. By Herman Hagedorn. New York: Harper & Brothers. 1927. $2.00.

IT is not easy to decide which is the more engrossing in this novel—the highly interesting and accurately historical picture of the development of the Rough Riders and of the characteristics of their leaders, Wood and Roosevelt, or the story of the regeneration of a rather useless bounder through the storm and stress of battle. Each is equally well told and the picture of the United States of 1898 flashes

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back to those of us who were small boys at the time with a vivid clearness that would be hard to duplicate. Mr. Hagedorn has done an artistic bit of work as usual. May the reader take to heart the tragic lesson of our unpreparedness at that time, with the devastating consequences for the men who suffered in Cuba from lack of food, clothing, equipment, transportation; in fact, a shortage of everything with which an army fights save morale.

Marching with Sherman. Passages from the Letters and Campaign Diaries of Henry Hitchcock, Major and Assistant Adjutant General of Volunteers. November, 1864-May, 1865. Edited with an introduction by Mr. A. De Wolfe Howe. New Haven: Yale University Press. $4.00.

WITHOUT previous military experience, Henry Hitchcock of St. Louis joined General Sherman's staff at Rome, Georgia, on October 31, 1864, serving as assistant adjutant general until the end of the war. The book, with an excellent introduction by Mr. Howe, is composed of Major Hitchcock's letters to his wife and a diary he kept when failure of communications with the North made it impossible to send letters. As an historical document it is of great value in showing the immediate impressions of General Sherman's policies, set down a few hours after the events, by one who could qualify as a "chevalier sans peur et sans reproche." For a vivid picture of the Georgia and Carolina campaigns and of the character of the various leaders, these letters and diaries are an unique source of first-hand information.

Checkmate—Fighting Tradition in Central Persia. By F. A. C. Forbes-Leith, R. A. S. C., F. R. G. S. New York: Robert M. McBride & Co. 1927. $3.50.

MAJOR FORBES-LEITH, a British officer, was engaged as general manager of a large estate in central Persia by a nobleman of that country. The estate comprised much land and included several villages. The contract was for five years. Major Forbes-Leith completed only two years, but during that time he had many exciting experiences which he narrates in this book.

He tells of the difficulties in trying to diminish the graft on which the parasitic herdsmen and all other officials grew wealthy. He depicts the extreme poverty leading to starvation; of filth, vermin and disease prevalent on all from childbirth and his efforts to improve these conditions. A particularly thrilling chapter is the tale of how he wiped out a notorious brigand. Cunning and intrigue practiced by those who lost the graft nearly succeeded in wrecking his administration. A change in polities in which his employer was caught on the wrong side and had to flee the country ended his contract.

It is a most interesting narrative of the graft, corruption, taxation of peasantry, and the feudal system of a country which twice practically ruled the then known world. It is pleasantly written and difficult to leave after once started.

The Cannoneers Have Hairy Ears: A Diary of the Front Line. Anonymous. New York: J. H. Sears & Co., Inc. 1927. $2.50.

THE artillery of the Great War has found a spokesman.

An anonymous genius has given us in vivid and picturesque language the sights and sounds and smells that fell to the lot of a lieutenant in a battery of 75's on the western

front. The realism of his descriptions in his day by day diary gives an adequate picture of modern warfare stripped of its glamor and reduced to its elemental aspect. The author has a keen sense of humor that relieves the tension at all times and in all places. Thousands of artillerymen will relive their war experiences in this book and those who failed to reach the front will be able to visualize what happened there. It is one of the most absorbing and certainly one of the best written war diaries that has appeared since the Armistice.

The Catastrophe. By Alexander F. Kerensky. New York: D. Appleton and Company. 1927. $3.00.

CONFUSION, treachery, cabals within cabals entered the political life of the Russian monarchy. Add to this a revolution in a great country with millions of illiterates during a great world war and you may get a brief image of what Kerensky describes in "The Catastrophe."

The Russian people were led to believe they would attain the millennium by a change of government. What the form of government would be was decidedly uncertain. The Provisional Government was established amid chaos and uncertainties on March 16, 1917, and ended November 14, 1917, when Kerensky was forced to flee to save his life.

It must be presumed that the Russian people did not appreciate the higher principles which actuated Kernesky and his partners in the Revolution, or the Soviets and Bolsheviki would not have found it so easy to overthrow this new government. Kerensky shows that it was only by the merest chance that Korniloff did not succeed in overthrowing the Provisional Government several months before the end came.

This book is Kerensky's defense of the part he played in the Revolution, as well as a vivid personal account of those eventful days.

A Pageant of India. By Adolph Waley. New York: Houghton Mifflin Company. 1927. $5.00.

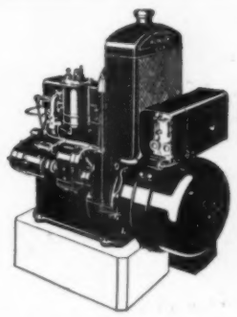
THE author presents a very complete and interesting history of one thousand years of advancement in India. Very vividly he conducts the reader through a perfect galaxy of rulers, from the time when Alexander the Great in 327 B. C. placed India in touch with the outside world to the death of Aurangzeb in 1707 A. D. The conflict between traditional India and invading Islam is dramatic and stirring. Later the introduction of Catholicism by Vasco da Gama adds to the turmoil of inherent fanaticism and religious zeal.

Throughout a clear picture of the times is obtained and with the portrayal of blood feuds, unrelenting hatred, intrigue, cunning and treachery intermingled with unswerving devotion, loyalty, love and pride of the Rajput race it becomes magnificent.

The great effect due to the introduction of musketry and artillery, inefficient as these arms were at that time, is illuminating.

While a great many of the characters who live in this book are not well known to the general reader, all of those who are, act their respective parts in India's advancement and bring to the reader a clearer and more sympathetic understanding of her manifold problems and charms.

This book is highly recommended to those who appreciate delightful history, clear character analysis and a keener insight into man's advancement through the ages.



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European Skyways: The Story of a Tour of Europe by Airplane. By Lowell Thomas. New York: Houghton Mifflin Company. 1927. $5.00.

THE public expects to receive from this author very readable and interesting books and in the present volume he fulfills these expectations admirably. It is opportune that one who has traveled so extensively by various modes of transportation presents so conclusively the advantages and disadvantages of aërial transports. Confidence in airplanes must be established to advance airways as rapidly as is consistent with airplane development. Such a book as this will do much to broaden the general knowledge concerning the present status of this industry and the result will be an increase in confidence and intelligent support of airway projects.

The reader involuntarily is caught with the enthusiasm of the author and understands more clearly that airplane travel is practical, necessary, and highly desirable. Travel by airplane in Europe is widely organized as the author makes apparent. It is also shown that at present there are few paying air lines. The attitude of the insurance companies is an excellent gauge of the degree of risk involved in flying and their attitude appears to be more and more favorable and should allay the doubts of the less informed public.

Modern Aircraft. By Major Victor W. Pagé, A. C. Res., U. S. A. New York: The Norman W. Henley Publishing Company. 1927. $5.00.

THE excellent publications of the author concerning automobiles are well known and have served a very useful purpose for years. His book on "Aviation Engines" and the present volume on "Modern Aircraft" extend this library to include the design and operation features of this newer mode of transportation. This book is most complete in all the features of aircraft, both lighter- and heavier-than-air types being thoroughly treated. It is sufficiently non-technical to appeal to the average reader interested in aëronautics and at the same time treats in a technical way those features which require such presentation to make it of great value for instruction purposes where a comprehensive knowledge of the general subject is desired. Ample references are provided for the design engineer and the aspects of commercial aviation are so treated as to present the practical problems which confront the proper development of aviation. The text is excellent in most particulars but it is clear that quotations must be more definitely indicated to realize their full value.

The value of this book is enhanced by its authoritativeness made evident by the inclusion of numerous opinions, descriptions, and information from recognized reliable commercial and governmental sources. No small part of its value is due to the profuse and detailed illustrations and diagrams. "Modern Aircraft" is recommended for general reading, for reference purposes, for home study, and for classroom instruction.

Air Facts and Problems. By Lord Thomson. New York: George H. Doran Company. 1927. $2.50.

WHEN an author, who has been England's former Secretary of State for Air as is the case with Lord Thomson, views his opinions concerning the past, present and future of aviation in peace and in war, the less fully informed

public should profit by his counsel. The defense of the United States is treated of and we find ourselves ten years hence equally as vulnerable as any European state to air attacks from Europe or Asia. As for his own country the author says, "The protection of the British Isles from attack by air must be the first and principal consideration." To further this defense he would subsidize the national aircraft industries or air transport companies or make some such provision.

Lord Thomson advocates a single control of all air forces and looks for disaster only in divided responsibility. He maintains that aviation is twenty years ahead of the average human intelligence, and this may in large part explain the diversity of opinion regarding a proper organization for air defense. He lays the failure of the United States to adopt a single control for air forces to a false idea of immunity from air attack.

The bombing airplane is conceded by him to be the most offensive weapon yet devised for reprisals, and against which no defense is yet in sight. He does not overlook the fighting airplane or the ground defense which he considers insufficient deterrents. He estimates that the war casualties of air forces in pilots and machines will be 80 per cent. per month or greater, and that air raids will extract a toll of ten civilians for each combatant killed. He would have air forces as shock troops and the holding forces the Army and Navy.

He visualizes the duty of this generation to organize aviation and believes that aggression should be made illegal and would outlaw war itself. Such humanitarian principles will receive wholehearted support by many, but such utopian results are hardly to be achieved in the near future.

The Growth and Development of the Pennsylvania Railroad Company. By H. W. Schotter. Philadelphia: Allen, Lane and Scott. 1927. $2.50.

IN this study of the charter and annual reports of the Pennsylvania Railroad Company from 1846 to 1926, inclusive, the author has prepared a painstaking analysis of the origin and subsequent history of this great transportation system. Since the narrative is frequently interrupted by the inclusion of lists of directors, lists of physical property, earnings, etc., it is by no means an easy book to read. As a source of data concerning the railroad, however, it is a valuable book of reference, and is presented in attractive form.

Influencing Human Behavior. By H. A. Overstreet. New York: W. W. Norton & Co., Inc. 1927. $3.00.

IT would be easy to apply all manner of superlatives in praise of Professor Overstreet's solution of the problem of attaining effectiveness within our human environment. Modern psychology has advanced to a point where its scientific knowledge can be used in practice by each one of us, and the author points the way in a delightful style with suggestions that can be followed readily. Are you interested in writing effectively, in speaking effectively? Then the author's investigation into the psychology of these two important activities will help you to a higher plane in writing and speaking. This fascinating book covers a wide field of human conduct and represents an extremely useful contribution of psychology to the ideal of becoming "skilled artists in the enterprise of life."

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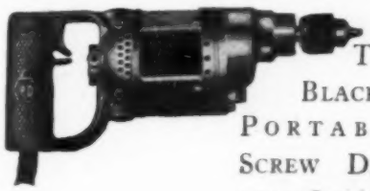

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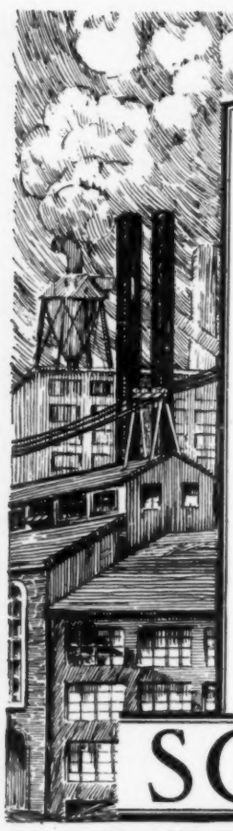

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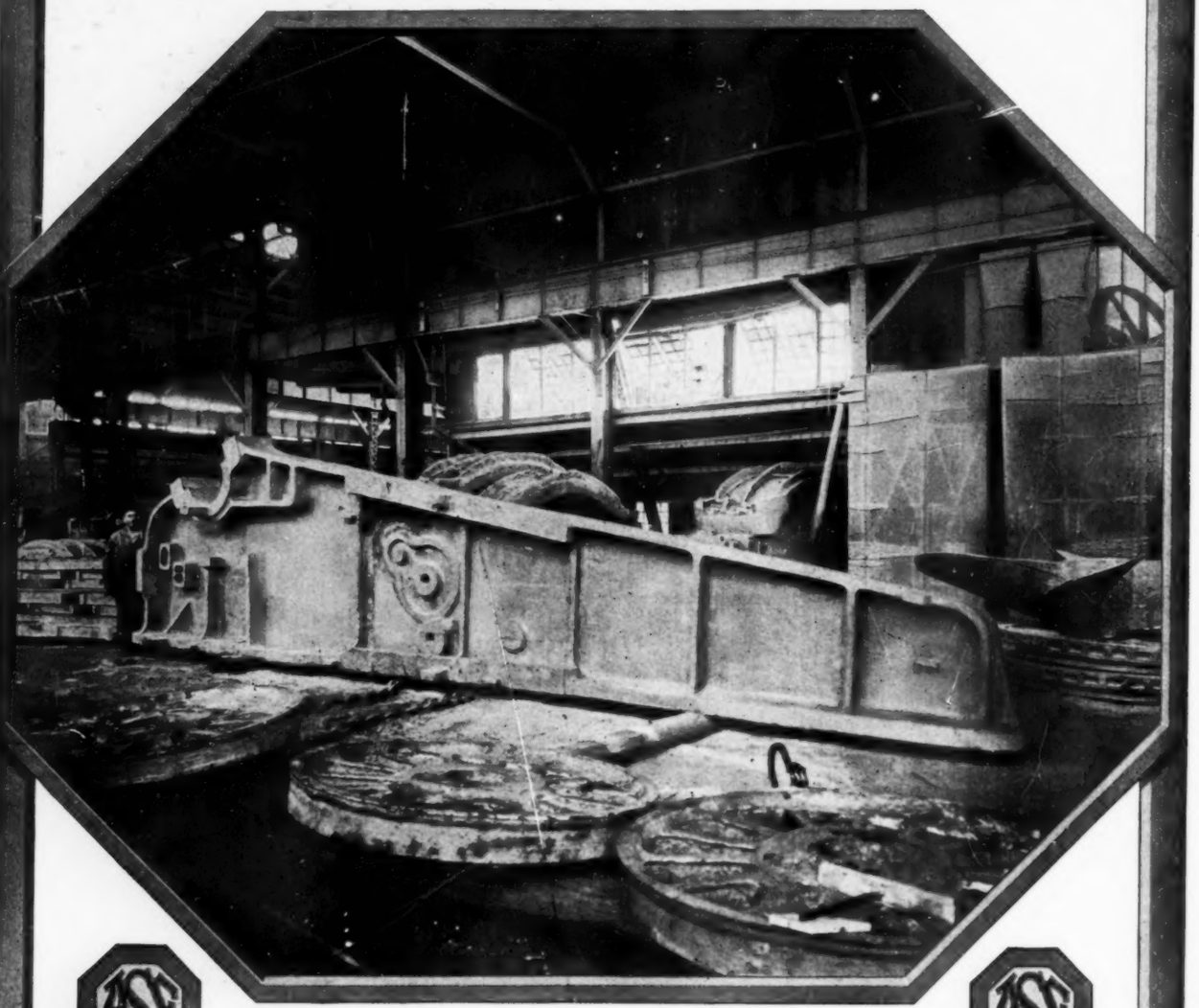

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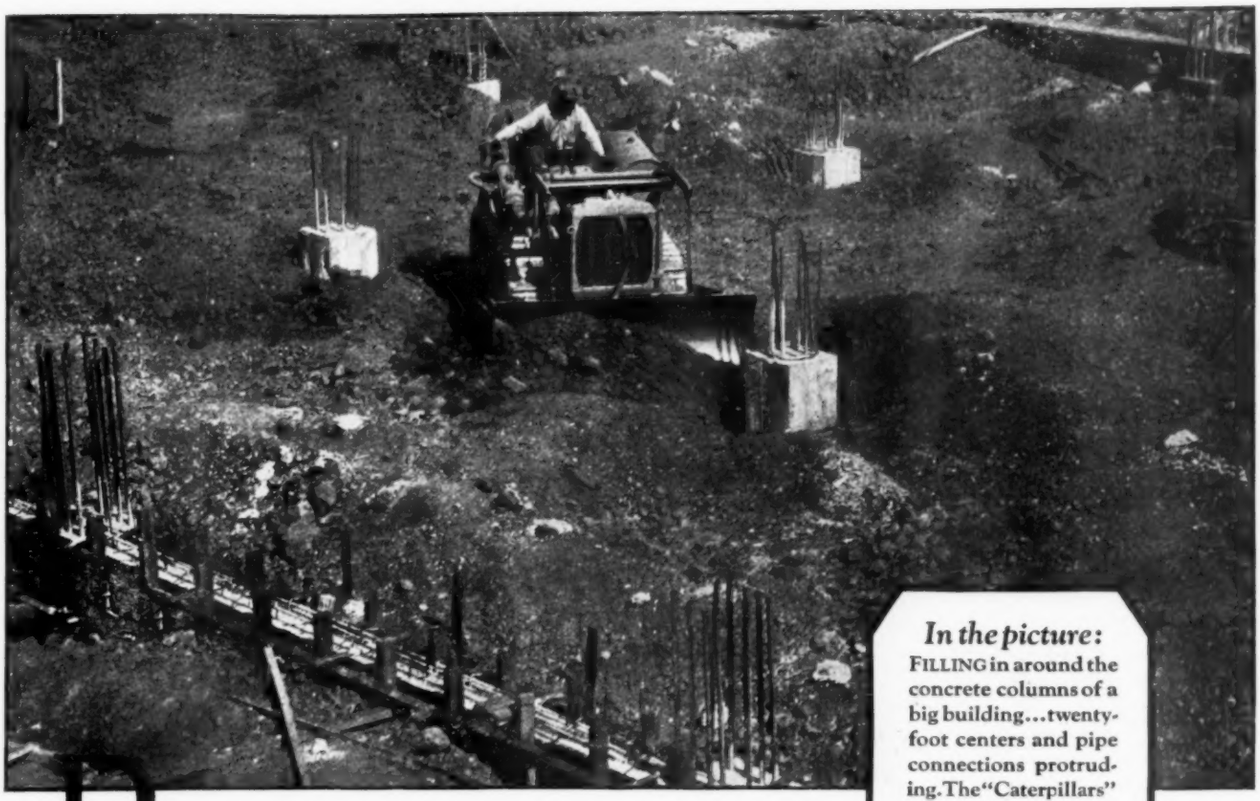

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This fort, made of soft palmetto logs and sand, mounted 30 guns and had a garrison of 344 officers and men of the 2nd Regiment of South Carolina Continentals commanded by Col. William Moultrie, after whom the fort was subsequently named.

When a shot from the fleet carried away the flag pole, which, with the flag, fell on the beach, Sergeant Jasper leaped from an embrasure, recovered the flag and fastening it on a sponge staff, mounted the parapet where amid the storm of shot he made fast the sponge staff, exclaiming: "We cannot fight without a Flag."

The battle continued until late in the evening when the fleet withdrew with a loss of 64 killed and 161 wounded, including the Commodore. One ship was abandoned and the others so seriously injured that they were out of action for several months. The loss in the fort was 17 killed and 20 wounded. This was the first defeat the British Navy had suffered in many years.

The day after the action, John Rutledge, the President of South Carolina, presented Sergeant Jasper with a sword and offered him a commission, which he refused.

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